B.Ed. Second Year

Paper- IX-B (i)

Teaching of Physical Sciences

Units: 1 to 8

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CONTENTS

B.Ed 2nd Year

Paper IX - B (i)

TEACHING OF PHYSICAL SCIENCES

Course objectives: **Marks: 50 (40 + 10)**

The student teachers will be able to:

1. Select and integrate various kinds of instructional media.
2. Organize various co-curricular activities.
3. Select appropriate text books.
4. Explain the concept of evaluation.
5. Plan lessons in physical science.

UNIT- I: **Learning Resources in Physical Sciences**

- Text Books- Meaning, Types, Importance, Uses and Evaluation of Text Books.
- Laboratory Materials- Importance, Planning, Designing and Maintenance of Different types of Laboratory Materials, Common Accidents and their prevention in Science Laboratories.
- Journals, Handbooks, Student's Work Books, Display-Slides, Audio-Visual Support Material, Smart Classrooms, e- learning Resources.
- Teaching Aids: Classification of Teaching Aids and Their Description. Importance of Teaching Aids in Teaching Physical Science; Preparation and Development of Low-cost Improvised Apparatus.

UNIT-II: **Planning for Teaching, Assessment and Evaluation**

- Unit and Lesson Planning: Need, Advantages, Steps, Various Approaches and Strategies of Lesson Planning.
- Meaning and Difference between Assessment and Evaluation; Evaluation in Physical Sciences- Importance and Types of Evaluation viz. Formative and Summative.
- Common Difficulties in learning Physical Sciences and Remedial measures- procedures in preparation of Criterion Referenced and Norm Referenced Tests.
- Evaluating Outcomes of Science Teaching; Preparing Different Type of Test Items and Their Advantages and Limitations; Diagnostic Testing and Remedial Teaching.

Activity (Any one of the following)

- Seminar on contribution of eminent Indian Scientists to science and their implication in science advancement.

- Developing an action plan for organization of a science exhibition, framing guidelines on a selected theme and various sub-themes.

Suggested Readings:

Das, R. C. (1989). *Science teaching in schools*.New Delhi:Sterling Publishers.

Kohli, V. K. (1998). *How to teach science*. Ambala: Vivek Publishers.

Kumar, A. (2002). *Teaching of physical sciences*. New Delhi: Anmol Publications.

Mangal, S. K. (1997). *Teaching of science*. New Delhi: Arya Book Depot.

Mohan, R. (2002). *Innovative physical science teaching methods*. New Delhi: P.H.I.

Sharma, R. C. (1998). *Modern science of teaching*. New Delhi: Dhanpat Rai and Sons.

Vaidyas, N. (1996). *Science of teaching for the 21st century*. New Delhi: Deep and Deep Publishers.

Kulshreshtha, R. P. (2010). *Teaching of physical science*.Meerut:R.Lall.

Tripathi, S. (2004). *Teaching of physical science*. Dominant Publishers and Distributors.

Sharma, Y. K. (2003). *Teaching of physical science-method and techniques*.

INSTRUCTIONS FOR THE CANDIDATES

Candidates are required to attempt one question each from the sections B and C of the question paper and entire Section A. Answer to short question should be completed in around 60-65 words each.

UNIT-1

LEARNING RESOURCES IN PHYSICAL SCIENCES

STRUCTURE

1.0 INTRODUCTION

In secondary education, the teaching of physical science is a vital component of the curriculum, shaping students' understanding of the natural world and laying the groundwork for advanced scientific learning. Educators use a variety of educational resources to effectively teach physical science at this level, enhancing learning experiences, promoting engagement, and helping students master complex concepts. Educational resources in physical science encompass a broad spectrum of tools and materials, including textbooks, multimedia content, laboratory equipment Interactive simulations and digital platforms support a range of teaching methods, catering to diverse learning styles and aiding students in developing a comprehensive understanding of scientific concepts

.

Textbooks offer organized, in-depth information, guiding students through core theories and their applications (Glencoe Science, 2020; Hewitt et al., 2021). Multimedia resources like videos and animations bring abstract bringing ideas to life, making them more captivating and easier to understand (Khan Academy, 2023; BBC Bitesize, 2023). Laboratory equipment enables students to conduct experiments, promoting hands-on learning and encouraging critical thinking (Flinn Scientific, 2019; Pasco Scientific, 2020). Interactive simulations and digital platforms offer immersive opportunities for students to investigate scientific phenomena in virtual environments, enhancing their understanding through active participation (PhET Interactive Simulations, 2023; Labster, 2023).

This unit aims to explore the importance of educational resources in the teaching of physical science at the secondary level. It will discuss the types of resources available, their role in enhancing the learning process, and strategies for effectively integrating them into the classroom. By understanding the value and application of these resources, teachers can create dynamic and engaging learning environments that inspire students to explore and excel in physical science. Through self-check exercises, readers will have the chance to assess their knowledge and application of educational resources, ensuring a thorough comprehension of the material. Additionally, the chapter will provide a glossary of key terms, answers to self-check exercises, and a list of references and suggested readings to further support educators in their professional development.

1.1 LEARNING OBJECTIVES

After completing this unit, learners will be able to:

- Identify different educational resources
- Understand the role and significance of science textbooks.

- Describe the Features of a Good Science Textbook.
- Evaluate Science Textbooks.
- Integrate Various Educational Resources.
- Reflect on the Application of Educational Resources.

These objectives aim to equip learners with a comprehensive understanding of The role and assessment of educational resources in teaching physical science, aimed at improving instructional practices and boosting student outcomes in science education.

1.2 EDUCATIONAL RESOURCES

Educational resources encompass a wide variety of tools,materials, and content used to facilitate teaching and learning processes across educational settings. These resources are designed to enhance instructional delivery, cater to diverse learning needs, and promote meaningful engagement with educational content (Marzano, 2007). Educational resources include a range of types, such as textbooks, multimedia content, laboratory equipment, interactive simulations, digital platforms, and more. These resources serve to support different teaching methodologies,

facilitate hands-on learning experiences, and provide students with opportunities to explore and apply theoretical knowledge in practical contexts.

Further, Educational resources encompass a wide array of materials and tools utilized to support teaching and learning processes within educational environments. These resources are crucial for supporting effective instruction, fostering student engagement, and promoting comprehensive understanding of academic subjects (National Research Council, 2012). Educational resources include textbooks, digital content, laboratory apparatus, interactive simulations, and other instructional aids. They are designed to accommodate diverse learning styles and enhance educational experiences by providing access to information, promoting interactive learning activities and enabling practical applications of knowledge. Educational resources for teaching physical science at the secondary level include both hardware and software tools that foster interactive and engaging learning experiences (Marzano, 2007).

Examples of Educational Resources

- *Hardware Resources:*
  - Laboratory Equipment: Physical science education often relies on laboratory equipment such as microscopes, spectrometers, and Vernier sensors to conduct experiments and collect data (Flinn Scientific, 2019; Pasco Scientific, 2020).
  - Interactive Whiteboards: These tools allow teachers to display and manipulate visual representations of scientific concepts, enhancing classroom interaction and engagement.
- *Software Resources:*
  - Simulation Software: Programs like PhET Interactive Simulations provide digital environments where students can explore physics principles through interactive simulations (PhET Interactive Simulations, 2023).
  - Digital Learning Platforms: Platforms such as Labster provide virtual labs where students can conduct experiments and analyze results in a simulated setting (Labster, 2023).

These resources support hands-on learning, promote critical thinking, and facilitate the application of scientific principles in secondary science education.

Self-Check Exercise- 1

(i) . Books comes under-

(a) audio media
(b) multi media
(c) printed media
(d) visual media

(ii) What are two examples of hardware educational resources mentioned for teaching physical science? Describe their roles in enhancing learning.

1.3 SCIENCE TEXTBOOK: MEANING, TYPE AND IMPORTANCE OF THE SCIENCE TEXTBOOK

(i) Meaning

Science textbooks at the secondary level are essential educational tools that aid in the teaching and learning of scientific concepts They provide structured material that aligns with curriculum standards, including explanations, diagrams, and exercises to help students grasp complex topics (Cohen, 2019). These textbooks act as primary instructional resources, guiding teachers and students through the curriculum and fostering critical thinking and scientific literacy (Chiappetta & Koballa, 2015). A physical science textbook is an educational resource designed to teach students about fundamental principles and concepts in physics and chemistry. These textbooks provide structured content that covers topics such as matter, energy, motion, forces, chemical reactions, atomic structure, and the periodic table. They are essential tools in secondary education, offering explanations, diagrams, mathematical equations, and problem-solving exercises to help students understand and apply scientific principles. Physical science textbooks aim to foster scientific literacy, critical thinking, and analytical skills among students by presenting information in a clear, organized manner that aligns with educational standards (Cohen, 2019; Chiappetta & Koballa, 2015).

(ii) Types of Physical Science Textbooks

- **General Physical Science Textbooks:** These provide an overview of basic physics and chemistry principles, covering topics like matter, energy, and motion, and introducing foundational concepts and scientific inquiry (Trowbridge et al., 2000).
- **Physics Textbooks:** Focused on areas such as mechanics, thermodynamics, electricity, and magnetism, these textbooks include mathematical equations and exercises to develop analytical skills (National Research Council, 1996).
- **Chemistry Textbooks**: Concentrate on the study of matter, chemical reactions, and the periodic table, covering atomic structure, bonding, and stoichiometry, with an emphasis on lab techniques (Chiappetta & Koballa, 2015).
- **Earth Science Textbooks:** These books cover geology, meteorology, and oceanography, using maps and diagrams to illustrate earth processes and highlight the connections within the physical sciences (Cohen, 2019).
- **Integrated Science Textbooks**: Combining elements of physics, chemistry, and earth science, these textbooks demonstrate the interrelated nature of scientific disciplines and encourage interdisciplinary learning (AAAS, 2001).

(ii) The importance of the science textbook:

- **Comprehensive Content Coverage**: Science textbooks provide comprehensive coverage of scientific concepts, theories, and principles across various disciplines such as physics, chemistry, biology, and earth sciences (Hewitt et al., 2021). They are structured to align with curriculum

standards and serve as primary resources for delivering essential knowledge in a systematic manner (Glencoe Science, 2020).

- **Structured Learning**: Textbooks offer a structured approach to learning, presenting information in organized chapters and sections that guide students through complex topics step-by-step (Hewitt et al., 2021) This structure enables students to develop foundational knowledge and grasp the logical progression of scientific concepts.
- **Clarity and Explanation**: Science textbooks are designed to present scientific concepts clearly and concisely, using language that is accessible to secondary-level students (Glencoe Science, 2020). They include explanations, definitions, and examples that aid in understanding abstract concepts and applying them to real-world scenarios.
- **Visual Aids and Illustrations**: Many textbooks incorporate visual aids such as diagrams, charts, and photographs to enhance understanding and clarify complex concepts (Hewitt et al., 2021). Visual representations assist students in visualizing scientific processes, structures, and relationships, thereby strengthening learning and enhancing retention.
- **Reference and Review**: Textbooks serve as valuable reference materials that students can revisit for review purposes, homework assignments, and exam preparation (Glencoe Science, 2020). They provide a reliable source of information that students can consult to clarify doubts or delve deeper into specific topics.

Science textbooks fulfill several essential needs in secondary education, contributing significantly to the learning process and academic development of students (Glencoe Science, 2020; Hewitt et al., 2021).

Self-Check Exercise- 2

What is the importance of a Science Textbook?

1.4 CHARACTERISTICS OF A GOOD SCIENCE TEXTBOOK

The characteristics of a good science textbook can be categorized intoexternal features and internal features. (Figure 1.1)

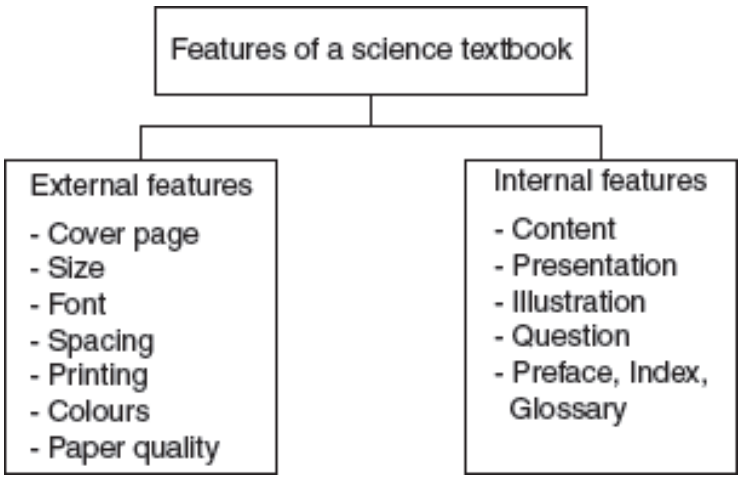

Figure 1.1 Features of a Science Textbook

(A) External Features

The external features of a textbook cover those aspects which make the appearance appealing, yet not directly related to the subject matter e.g. paper, printing, outer look, etc.

(i) **Cover page:** The cover page of the book should be attractive and colourful. It helps in leaving an impact on the minds of the reader. Cover page may bear visual images from all three branches of science. It can also carry the necessary information like the name of the book, class, author, publisher, etc.

(ii) **Size:** The size of the book should be such that the book is easy to carry and better to handle. An ideal size could be 26 cm x 20 cm.

(iii) **Font size:** The font size for headings and subject matter should be chosen keeping in mind the age level of students. For the young children, bigger font size is better, whereas, smaller font size is more appropriate for the grown up children. Noteworthy words, phrases or sentences should be highlighted either with italics or in a bold font.

(iv) **Spacing:** Appropriate spacing between the words, sentences and paragraphs should be given. There should be enough space for making diagrams, flow charts and illustrations wherever needed to support the subject matter. Margins are also a must on all the four sides of a page, i.e., upper, lower, right and left.

(v) **Printing:** Printing of the text should be clear and appealing to the reader. Mistakes should be avoided as much as possible. Heading should be avoided as much as possible.

(vi) **Colours:** Heading and sub-headings can be printed in different colours to distinguish them from the content.

Quality of the paper: The paper used for printing is decided keeping in mind the age level of students as well as the expected cost price. Very expensive books do not gain popularity with students. Glossy paper is more suitable for the books meant for lower classes, as These books are not overly thick, and the glossy paper used tends to make them heavier. Regardless of the type of paper selected, it should be of high quality, smooth to the touch, and have a clean, white appearance. The paper used for the cover page should be thick and durable.

(B) Internal Features

The internal features of a science textbook refer to aspects such as content organization, presentation, illustrations, questions, and references.

(I) Contents: The content of the book should align with the syllabus for that particular class. It should be organized in a way that enables students to develop a solid understanding of the subject matter while also sparking their interest and engagement with the topic.

The contents of the book should be arranged in a very relevant and systematic manner and in a proper sequence. The maxims of teaching like proceeding from simple to complex and from known to unknown should be kept in mind while Organizing the subject matter should follow a logical progression, with easier chapters placed first and more challenging ones following thereafter.

(I) Presentation: Each chapter should be well-presented with vibrant and engaging diagrams that facilitate a clear grasp of the content. Newscientific concepts should be introduced with practical examples. While presenting the chapters, the principles of moving from the concrete to the abstract and from direct to indirect concepts should be followed. Each chapter can begin with relevant examples and then tie them to the main topic effectively. Subtopics should be presented systematically with each concept building on the previous one. The language should be simple and clear and accessible. The book should prioritize "learning by doing," with every chapter containing activities designed to reinforce key facts and concepts. Activities can be included throughout the chapter and at the end to reinforce the material. Science is best learned through real-life examples, hands-on experiences, and activities, so these elements should be incorporated into all topics.

(II) Illustrations: The importance of illustrations is captured by the Chinese proverb, "A picture is worth a thousand words." Illustrations can include pictures, figures, flowcharts, diagrams, graphs, and more. These visuals help students visualize concepts and gain a more thorough understanding of the topic.Diagrams should be clearly drawn and well-labeled, and figures and graphs should be explained in relation to the written content. The size of the illustrations should be proportionate to the text and page size. Real photographs can also be included to depict natural events, such as earthquake, floods, tsunami, etc. Pictures and diagrams of abstract and microscopic things like cell, bacteria, atom, etc. should be very precise and clear to ensure the concept is clearly understood.

(I) Questions: Exercises serve as practice, assessing both the theoretical and practical knowledge of students.Further, exercises increase the students' hold on the topic and make the learning firm and long lasting. Each chapter in the science book should have a variety of questions, e.g., tick the correct answer, fill in the blanks, true or false, match the following, find the odd one out, distinguish the following, give reasons, answer the following, draw the diagram, solve the numerical, etc. Questions in the exercise should cover the whole chapter and should include simple as well as difficult questions. Some thought-provoking questions should be given separately in the chapter especially for the bright students.

Preface, Index, Glossary: The book should have a suitable preface as it describes the book, the class for which it is written, the author and the objectives of the book. There should be an index of contents mentioning the chapters and their details along with the page numbers. There should be a distinct list of tables or graphs, presented clearly and in a way that is easily accessible to students.. The language should be simple and easy to understand, with minimal jargon, to ensure students grasp the core concepts effectively.

Each chapter should include a glossary of key terms and their definitions at the end, with a final glossary containing all the terms listed at the back of the book. This serves as a useful tool for students to easily reference key terms whenever needed.

Self-Check Exercise-3

(i) A good textbook consists of ... and ... features.
(ii) Mention the internal features of a good science textbook.

1.5 Evaluation of a Science Textbook

Evaluating a secondary-level science textbook involves assessing various criteria to ensure it meets educational standards and effectively supports student learning (Glencoe Science, 2020; Hewitt et al., 2021).

I. Accuracy and Currency: Review the textbook's scientific information for accuracy. Verify that the content aligns with the latest scientific knowledge and research (Hewitt et al., 2021).

II. Content Coverage: Assess the comprehensiveness of the textbook make sure that all key topics and concepts are covered equired by the curriculum standards for secondary-level science education are covered (Glencoe Science, 2020).

III. Clarity and Readability: Assess the clarity of the explanations and the readability of the text. Ensure that complex scientific concepts are conveyed in a clear, understandable manner, using simple language to enhance comprehension clearly and concisely in language appropriate for secondary-level students (Hewitt et al., 2021).

I. **Quality of Visual Aids**: Assess the quality and relevance of visual aids such as diagrams, charts, graphs, and photographs. Visual elements should effectively supplement the text, enhance understanding, and illustrate key concepts (Glencoe Science, 2020).
II. **Pedagogical Features**: Look for pedagogical features such as learning objectives, summaries, review questions, and hands-on activities. These features should support learning goals, facilitate comprehension, and offer opportunities for student involvement and practical applicationHewitt et al., 2021).
III. **Alignment with Educational Goals**: Evaluate how well the textbook aligns with educational goals and learning outcomes specified in the curriculum standards. It should support the development of critical thinking skills, scientific inquiry, and problem-solving abilities among students (Glencoe Science, 2020).

Typically, at the school level, textbooks are prescribed for lower-grade students, and they don't engage in independent reference work. For higher-grade students, in addition to the prescribed textbooks, science teachers recommend reference books.

Before recommending, the teacher can objectively analyse and evaluate the book. A very comprehensive textbook evaluation rating scale is being given here:

Scales of Evaluation	Excellent 5	Good 4	Average 3	Poor 2	Poorest 1
1. External Features					
i. External look of the book					
ii. Size of the book					
iii. Price of the book					
iv. Suitable font					
v. Appropriate spacing					
vi. Size/width of the margins					
vii. Clarity of printing					
viii. Durability of binding					
ix. Quality of the paper					
2. Internal Features					
i. Content					
- Selection of the content					
- Logical classification of the content					
- Sequence of lessons					
- Integration of the content					
ii. Presentation					
- An attractive and appropriate title					
- Style					
- Free from biases					
- Vocabulary					
iii. Illustrations					
- Accuracy					
- Objectivity / relevance					
- Quality					
- Size / proportionate					
- Colour combination					
iv. Questions					
- Related to the subject matter					
- Comprehensive					
- Sequence of the questions					
v. Preface, index, glossary, etc.					
- Suitable					
- Effective introduction					
- Usability					
- Complete					
- Relevant					
Total					

A textbook must realize the basic curricular objectives of different stages. Due to the examination system, rote learning has become a major problem. Textbooks can provide solution to this by including meaningful questions and by following application and problem-solving approach. Textbooks should link the textual material to the daily life experiences and this would reinforce the learning in students.

Self-Check Exercise- 4

Question: How can you ensure a science textbook meets educational standards at the secondary level?

1.6 Summary Educational resources in physical science encompass a broad spectrum of tools and materials, including textbooks, multimedia content, laboratory equipment, interactive simulations, and digital platforms. For higher-grade students, in addition to the prescribed textbooksreference books are recommended by the science teacher. Before recommending, the teacher can objectively analyse and evaluate the book. Diagrams should be clearly drawn and well labelled. Figures and graphs should be explained in relation to the written content. The size of the

illustrations should be proportionate to both the page and the text. After the introduction, different sub-topics should be presented in a structured and logical sequence. such that a topic is directly related to the one preceding it. Simple and lucid language should be used in writing the content. The book should have proper emphasis on ‘learning by doing’. Every chapter should have a number of activities to establish facts and concepts in the minds of the learners.

1.7 GLOSSARY

Educational Resources: Educational resources are the tools or materials, whether hardware or software, used in a learning environment to improve the teaching-learning process.

Textbook Evaluation: It is a systematic process of analysing and assessing the quality, accuracy, relevance, and effectiveness of a textbook or instructional material to determine whether it meets the demands of educational standards and curricular objectives.

1.7 ANSWERS TO SELF-CHECK EXERCISES

Self-Check Exercise- 1

(i) (c) printed media

(ii) Two examples of hardware educational resources for teaching physical science are laboratory equipment and interactive whiteboards.

Laboratory Equipment: Laboratory equipment such as microscopes and Vernier sensors are crucial for conducting experiments and collecting data in physical science. They provide students with hands-on experience and facilitate the application of theoretical concepts in practical settings (Flinn Scientific, 2019; Pasco Scientific, 2020).

Interactive Whiteboards: Interactive whiteboards allow teachers to display and manipulate visual representations of scientific concepts. They enhance classroom interaction by enabling real-time annotations and explanations, which aids in student comprehension and engagement.

Self-Check Exercise- 2

Importance of the Science Textbook:
• Textbooks provide factual information and foster a deeper understanding of concepts and principles.
• Textbooks preserve and store knowledge and wisdom for future reference.
• Textbooks serve as a guide to facilitate student learning.
• Textbooks set and reflect academic standards.
• Textbooks help achieve the foundational curricular objectives at various educational levels.

• Textbooks offer students the opportunity to reflect on and assess their learning.
• Textbooks promote educational interaction between teachers and students

Self-Check Exercise- 3

(i) . external and internal

(ii) Internal features of a good science textbook include:

- The content should align with the syllabus for that specific class.

• Each chapter should feature vibrant and engaging diagrams to deepen understanding of the subject matter. Illustrations or examples, such as pictures, figures, flowcharts, diagrams, and graphs, must be clearly provided each chapter in the science textbook should have a variety of questions, for example, fill in the blanks, true or false, match the following, choose the odd one out, etc.

- A good textbook of science must have a suitable preface, a proper index and a glossary of important terms.

Self-Check Exercise- 4

- By evaluating its accuracy, content coverage, clarity, quality of visual aids, pedagogical features, and alignment with curriculum goals (Glencoe Science, 2020; Hewitt et al., 2021).

1.8 REFERENCES/ SUGGESTED READINGS

AAAS Project 2061. (2001). *Science Textbooks: Tools for Teaching and Learning Science*. American Association for the Advancement of Science.

BBC Bitesize. (2023). *GCSE Physics*. Retrieved from https://www.bbc.co.uk/bitesize/subjects/zrkw2hv

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Trowbridge, L. W., Bybee, R. W., & Powell, J. C. (2000). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy*. 7th ed. Prentice Hall.

1.9 TERMINAL QUESTIONS

1. Why is a science textbook considered a crucial resource for a science teacher?
2. What are the key characteristics of an ideal science textbook
3. How will you evaluate a science textbook?
4. Critically analyze a textbook of science of any class and suggest the improvements.

UNIT- 2

SCIENCE LABORATORY

STRUCTURE

2.0 INTRODUCTION

A well-equipped laboratory is crucial for effective and efficient science education. A significant portion of learning time should be dedicated to hands-on activities, whether through demonstrations in the classroom or individual/group work in the laboratory.

Science also contributes to the development of various values, such as intellectual, utilitarian, cultural, moral, and aesthetic values.These outcomes can only be achieved if students have the opportunity to test their knowledge of principles and theories through experiments and practical work. In other words, effective science teaching requires a well-equipped laboratory.With the implementation of the improved science curricula in the various states, and as recommended by Kothari Commission (1964–1966) to implement the scheme 'Science For All' throughout the school stage, and also the work done by the N.C.E.R.T. in this respect, it has become imperatively important to implement different means of providing better teaching learning situations within the frame work of school education.

Physical facilities in science, perhaps, are those provisions in schools which facilitate the teacher and pupil to have ideal teaching-learning situations and to utilize them effectively with understanding in a simple and easier way to achieve the desired aims The goals and objectives of science can be achieved in a relatively short amount of time.

Additionally, it is important to keep students connected with the latest advancements in science while addressing their individual needs. Resources are the tools and materials that support learning experiences and help create a conducive environment for education.

From this, we can conclude that by learning resources, we mean all those things such as people, programmes, instructions, materials, physical facilities, necessary equipments and tools, etc.

2.1 LEARNING OBJECTIVES

After completing this unit, you will be able to:

- Comprehend the purpose and structure of content related to science laboratories.
- Acknowledge the importance of laboratory work in scientific education.
- Explain the role of science laboratories in practical scientific learning.
- Discuss how experiments help reinforce theoretical concepts.
- Describe the essential features and characteristics of an effective science laboratory.
- Evaluate existing laboratory facilities based on these characteristics.
- Evaluate their knowledge of laboratory characteristics through self-assessment questions.
- Understand the importance of discipline and safety in a science laboratory environment.
- Follow established protocols for behavior and safety in laboratory settings.
- Identify common laboratory accidents and their causes.
- Propose appropriate remedies and preventive measures for these accidents.

2.2 IMPORTANCE OF SCIENCE LABORATORY

Science laboratories Play an essential role at the secondary level by providing students with practical experiences that enhance their understanding of scientific principles through practical application (National Research Council, 2006; Hodson, 1998). We need science laboratory for:

1. **Experiential Learning**: Laboratories offer students the opportunity to engage directly with scientific concepts and phenomena, facilitating experiential learning that reinforces theoretical knowledge acquired in classrooms (Hofstein & Lunetta, 2004).
2. **Development of Practical Skills**: Laboratory activities promote the development of essential practical skills such as observation, measurement, data collection, and analysis. These skills are integral to scientific inquiry and critical thinking (Hodson, 1998).
3. **Encouragement of Inquiry-Based Learning**: Laboratories encourage inquiry-based learning, where students formulate hypotheses, design experiments, and draw conclusions based on evidence. This approach fosters curiosity, creativity, and problem-solving abilities (National Research Council, 2006).
4. **Real-World Application**: Practical experiments conducted in laboratories often simulate real-world scenarios, allowing students to apply scientific principles in contexts that mimic professional scientific practices (Hofstein & Lunetta, 2004).

Self-Check Exercise- 1

I. What is the main purpose of science laboratories at the secondary level?
II. Identify one key skill students develop through laboratory activities. How does this skill contribute to scientific inquiry?

2.3 CHARACTERISTICS OF A GOOD SCIENCE LABORATORY

An ideal science laboratory and its key features are illustrated in Figure 2.1

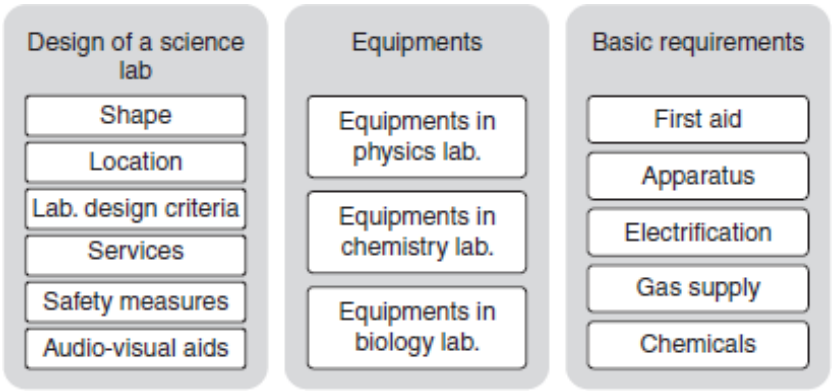

Figure 2.1 Features of a Science Laboratory

I. Design of Science Laboratory: The design of a laboratory should be a cooperative exercise between the architects and those engaged in science education and administration. The plan and design of a laboratory must provide elements of flexibility.

1. **Shape:** Most schools possess a rectangular shaped laboratory. An ideal laboratory for about 30 students should have a floor area of 89 m^2 (960 ft^2) which provides approximately 3 m^2 floor area per pupil. Six factors are of particular importance while planning the layout of a science laboratory. These factors clearly reflect the main attributes in science teaching i.e. pupils doing individual practical work, writing or watching a demonstration. The factors are:

    a. *Linear bench shape*: The provision of 1 linear meter of bench space per pupil is advisable.
    b. *Circulation space*: The provision of 1.7 meter of space between the ends of benches and walls to provide circulation space and room for wall furniture.
    c. *Storage*: Space for cup-boards and shelves in the laboratory for storage of apparatus and other materials is common.
    d. *Permanent equipment*: Space for installation of non-movable equipment like aqua, balance, oven, H_2O bath.
    e. *Wall space*: Space for apparatus which needs to be fixed in vertical plane.

2. f. Demonstration bench: A demonstration bench should be provided for teaching purposes, allowing for both demonstrations and individual practical work**Location**

    There are several advantages in having all the science laboratories together to form a science block:

    a. the movement of staff and apparatus is reduced.
    b. availability of technical assistance is increased.
    c. work of an inter-disciplinary nature can be developed easily.
    d. Installation expenditure of services such as gas, electricity, water and drainage can be kept to a minimum.

3. **Laboratory Design Criteria**

    A science laboratory must be designed for a variety of activities like:

    a. Practical work by individuals or small groups. These activities require the usual range of services near fixed or movable work benches.
    b. Study activities like writing experiments, making observations and drawing diagrams. Recommended height of working surface for seated work in 75 cm and for stool is 50 cm.
    c. Lecture/Demonstration: It can be done at an ordinary work bench or a special demonstration bench which has space to receive a trolley.

d. Discussion: Movable tables that can be arranged to create space for class discussions, facilitating effective interaction.

d. Audio-visual aids: Using a projector or a T.V. Viewing of films through a projector requires dim light in the laboratory, therefore, fire-proof black out curtains should be present.

e. Display/exhibition areas; For displaying charts, models, projects, etc., provision of pin board areas at all places is essential.

g. **Storage** A laboratory should have a storage room with preparation areas where materials can be organized and distributed to the lab. This room should be equipped with cupboards and drawers or trays for storing items, with some lockable cupboards specifically for storing valuable or hazardous material

h. **Preparation Area**: The preparation area should be equipped with standard services like gas lines, sinks, etc. Additionally, a portion of the workbench should be covered with fire-resistant material

Services

The services include gas, electricity and water supplies. A laboratory must have permanently fixed services in fixed benches or service stations along the sides of the laboratory. There should be two or three additional service stations for electricity and gas connections, positioned in the center of the laboratory. For lighting, each bench should be equipped with lamps to support microscopic work.

4. **Safety Measures**

a. Design of the laboratory should be such that all pupils can be supervised easily while doing practical work.

b. The laboratory floor should be resistant to minor spillage. It can be polished or varnished, but must not be slippery. It must also be free from cracks.

c. The wall and floor fitting must not protrude unnecessarily into laboratory working space.

d. There should be a designated area for storing students' bags and other items that need to be set aside during practical work

e. Windows should be easily operable, and blinds should be adjustable without the need to climb on benches.

f. The laboratory design should ensure that the teacher can easily access the main gas, water, and electricity controls, which should be placed near the exit doors. Students should also be aware of the location of these controls to handle emergencies

d. First aid kit must be provided in adequate number and should kept at accessible places. Pupils must be aware of the location and content of the kit. They must also be aware of its usage.

5. Audio-visual Aids

Various audio-visual aids recommended for science laboratory are illustrated in figure 2.2. They are:

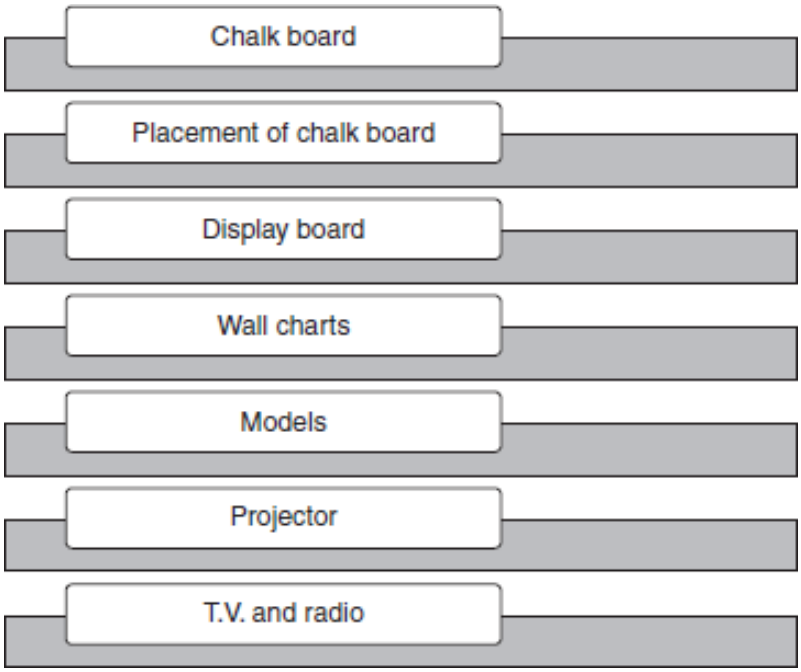

Figure 2.2 Types of Audio-visual Aids

1. *Chalkboard*: Chalkboard is a board with a surface that allows chalk to rub off a stick on to the board. Most commonly used chalk board is the black board, but other colours, particularly green, are also used.
2. *Placement of the chalkboard*: Lighting conditions vary throughout the day, so it is crucial that the light reflecting off the chalkboard does not hinder students from reading the information written on itTo ensure this, blinds must be provided on windows which can be pulled down for shielding against light. For adequate illumination, artificial lighting can be provided.
3. *Display board*: Some wall space in laboratory must be given to pin board or other surface for display of articles, notices, etc.
4. *Wall charts*: Wall charts can be made in the school by pupils or teachers or can be bought from commercial suppliers. Charts should not be over used. It will be ignored if used for a long time.
5. *Models*: Models are used to convey an appreciation of three-dimensional structure. Models can be static or working.
6. Projector: Different types of projectors are used in schools, including slide projectors, filmstrip projectors, overhead projectors, and micro projectors
7. *T.V. and radio*: T.V. telecast includes various programmes for schools. School time table should be adjusted according to the T.V. schedule.

II. Equipments: Some equipments are same for the Physics, and Chemistry laboratories. But some equipments are specific to a subject.

1. **Equipments for Chemistry Laboratory:** The recommended equipments for a chemistry laboratory are as under:

    a. Cupboards (wooden and steel).
    b. Wall board or black board.
    c. Demonstration table (8'X4') with cupboards, water and gas points.
    d. Working tables with cupboards, shelves, water and gas points.
    e. Balance room should be attached to the laboratory.
    f. Sinks on each working table or at least two large sinks at the corners of the laboratory.
    g. A wooden box half filled with sand to be used as a waste material box.
    h. A full cupboard.
    i. Acid proof drainage system.
    j. Shelves for reagent bottle on each working table and wall shelves for storage of reagent bottles.

2. **Equipments for Physics Laboratory**

    a. Working tables of about 6'X3.5'X3' with inside drawers.
    b. One demonstration table with water, gas and fitting.
    c. Blackboard at the back of demonstration table nicely painted.
    d. Sinks.
    e. Cupboards may be wooden or with glass pane.
    f. Stools.
    g. Separate balance room if schools can afford it. Otherwise, projected platform windows or space in the walls may be used for keeping balances.

III. Basic Requirements of a Laboratory: Any science laboratory is incomplete without certain essential things. These requirements are given below:

1. **First Aid Box:** It is a basic requirement of every laboratory. It should contain the following materials:

    a. Bandages (3-4 rolls of different sizes), gauze, lint, cotton wool, leucoplast.
    b. A pair of forceps, a pair of scissors, safety pins, glass dropper, two eye glasses.
    c. Vaseline, boric acid power, sodium bicarbonate powder, a tube of burnol.
    d. Sarson oil, olive oil, glycerin.
    e. 1% acetic acid solution, 1% boric acid, 1% sodium bicarbonate, saturated solution of sodium carbonate.

f. Methylated spirit, rectified spirit, dettol.

2. **Apparatus:** Every laboratory requires some apparatus for its functioning and to conduct experiments e.g. beaker, conical flask, test tubes stand, pipette, burette, Petri dishes, watch glasses, slides, microscopes, etc.

3. **Electrification of Laboratory:** A good light system is very important factor in the laboratory for students' tables, demonstrations tables and blackboard. A well lighted laboratory aids in better practical work.There should be some arrangement for darkening and controlling the intensity of light. Sufficient care should be taken of switches, fans and other electrical arrangements. No point should be left loose. There should be some arrangement for A.C. and D.C.

4. **Gas Supply:** Gas supply is required for all laboratories, especially in chemistry laboratory, it is indispensible. There may be coal gas plant, kerosene oil gas plant or petrol air gas plant. Mostly air gas (petrol) plant is installed in schools as:

a. Its cost is low.
b. It is easy to handle.
c. It is easily available.

A gas plant should be in a small room attached to the laboratory. Gas controllers should be fitted on every working table which can be used when required.

5. **Chemicals:** Chemicals are one of the basic requirements of every laboratory especially in chemistry laboratory. In storage of chemicals the following methods are normally adopted:

1. Grouping the chemicals in a systematic way.
2. Arranging the chemicals and elements in an alphabetical order.
3. Numbering each bottle and jar and keeping an index book.

Self-Check Exercise- 2

1. Mention the equipment required in a chemical laboratory.

2.4 Ideal Science Laboratory Designs

An overview of the design layouts for Physics and Chemistry laboratories is provided in the figures 2.3 and 2.4 respectively.

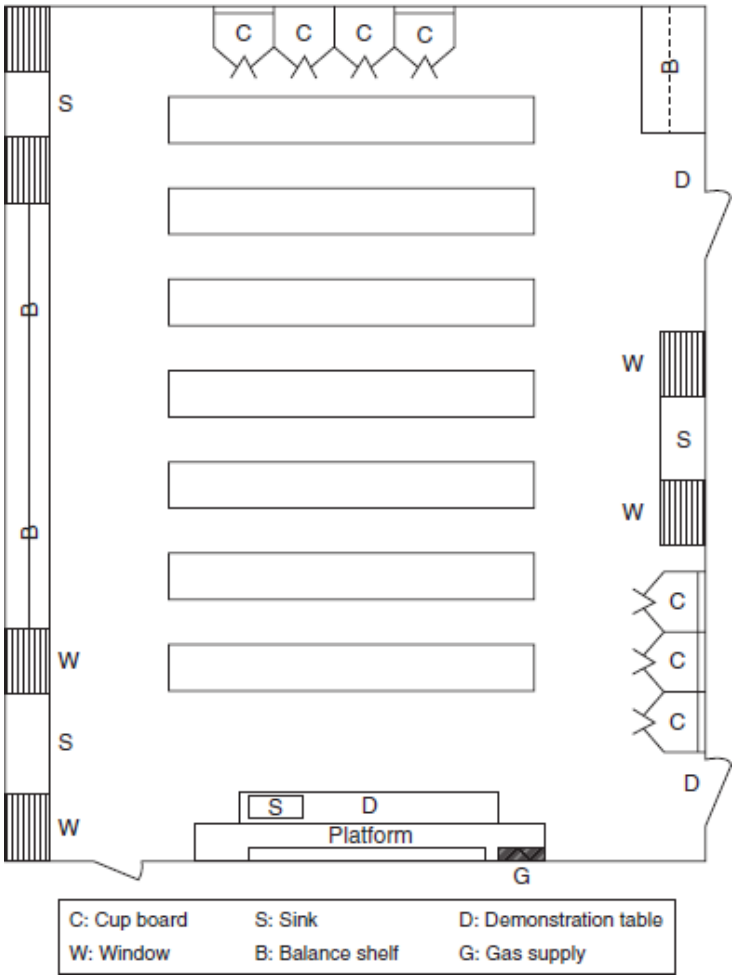

Figure 2.3 Physics Laboratory

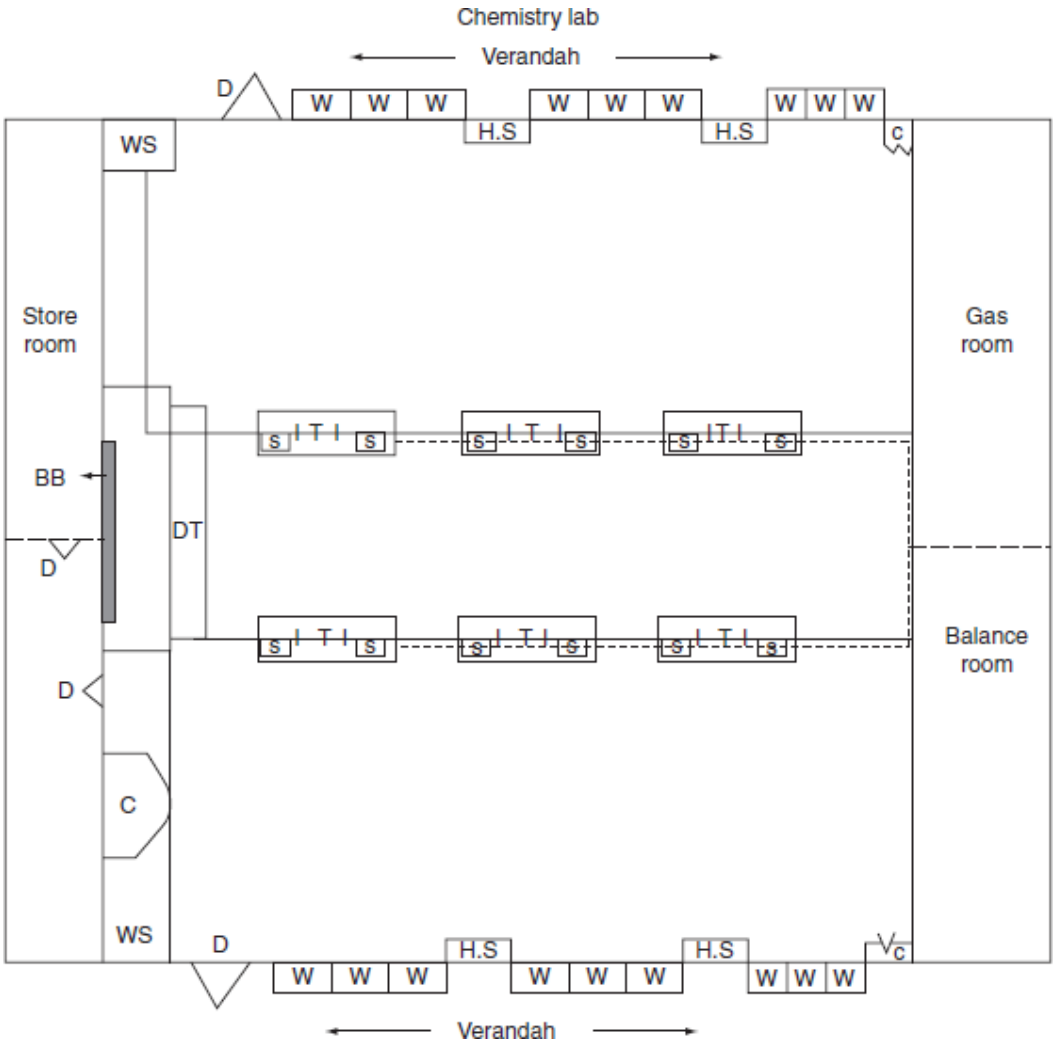

Figure 2.4 Chemistry Laboratory

2.5 MAINTENANCE OF RECORDS

A science teacher is required to maintain the following records:

1. **Stock Register of Chemicals**: This register should list the names and descriptions of chemicals in alphabetical order. The stock should be checked monthly, and if necessary, weekly. This register will also serve as a record for consumable items.
2. **Permanent Stock Register**: This register should include all non-consumable, durable items, such as apparatus, equipment, models, and specimens made of metal, wood, or unbreakable materials. The list should be organized alphabetically and contain details like the date of purchase, quantity, manufacturer's name, etc. Any faulty or damaged items should be recorded in the remarks section.
3. **Stock Register for Breakable Articles**: This register should list all fragile items, such as glassware and china items, including beakers, troughs, thermometers, and models made from delicate materials.
4. **Order Register**: This register should document all items ordered and received for the laboratory, including apparatus, equipment, chemicals, specimens, and models. The columns should include the order date, order

details, supplier's name, price, quantity purchased, delivery or receipt date, payment date, voucher details, and remarks about the material quality. A copy of the vouchers should be attached to the appropriate section of the register. A special section may also be included for items received through grants or donations.

Self-Check Exercise- 3

Details Included in the Stock Register of Chemicals:

2.6 **Laboratory Discipline**

A teacher should ensure discipline is maintained in the laboratory and manage students' behavior while they are working. The following rules can help prevent accidents in the laboratory.

- Admission to the laboratory in the absence of a teacher should be avoided.
- Teacher should not be late unduly.
- Teacher should address the whole class.
- Teacher should see that complete silence is observed during the instructions.
- Teacher should change his pitch at times to add interest to his/her talk.
- Teacher should make adequate preparation to keep the class busy.
- The teacher should see and remove all possible causes of trouble.
- Adequate apparatus should be made available.

Self-Check Exercise- 4

Mention any four rules to be followed in a laboratory.

2.7 COMMON ACCIDENTS AND THEIR REMEDIES

Laboratory is a place where accidents do happen often. Students may get hurt due to burns or cuts or gases. A science teacher should be able to identify the injury and do the needful. Various possible injuries and The recommended first aid measures have been provided in figure 2.5. These are:

Burns	Cuts	Eye injuries	Poison	Gases	Fire
• Dry burns • Acid burns • Alkali burns	• Minor cuts • Serious cuts	• Acid in eye • Alkali in eye • Foreign particle in eye	• Salts • Acids • Caustic alkalies • Arsenic or mercury compounds	• Chlorine • Sulphur-di-oxide • Bromine vapours	• Burning clothes • Burning reagents

Figure 2.5 Common Accidents in a Science Laboratory

1. Burns

- Burns by dry heat (i.e. by flame, hot objects etc.). For slight burns apply Burnol and Sarson Oil. In case of blisters caused by burns, apply Burnol at once and rush to the dispensary.
- Acid burns**:** Wash with water and then with a saturated solution of Sodium Bicarbonate and finally with water. Even after this if the burning persists wipe the skin dry with cotton wool and apply Sarson oil and Burnol. In case of Concentrated Sulphuric Acid, wipe it from the skin before giving the above treatment.
- Alkali burns**:** Wash with water and then with 1% acetic acid and finally with water. Dry the skin and apply Burnol.

2. Cuts

- In case of a minor cut allow it to bleed for a few seconds and remove the glass piece if any. Apply a little methylated spirit or Dettol on the skin and cover it with a piece of Leucoplast.
- For serious cuts call the doctor at once. In the meantime, try to stop bleeding by applying pressure above the cuts. The pressure should not be applied for more than five minutes. Minor bleeding can be stopped easily by applying conc. ferric chloride solution or alum.

3. Eye Injuries

- Acid in eye: At once wash the eye with water a number of times. Then wash it with 1% sodium carbonate solution by means of an eye glass.
- Alkali in eye; At once wash with water and then with 1% boric acid solution by means of an eye glass.
- Foreign particles in eye**:** Do not rub the eye. Wash it with sprinkling water into the eye. Open the eye and remove the particle by means of clean handkerchief. Again, wash with water.

4. Poison

- Salts; If a solid or liquid goes to the mouth but is not swallowed, spit it at once and repeatedly wash with water. If the mouth is sealed, apply olive oil or ghee.
- Acids: Dilute by drinking lots of water or preferably with milk of magnesia.
- Caustic alkalis: Dilute by drinking water and then drink a glass of lemon or orange juice.
- Arsenic or mercury compounds: Immediately give an emetic, e.g., one table spoon full of salt or zinc sulphate in a tumbler of warm water.

5. Inhalation of Gases

Pungent gases like chlorine, sulphur-di-oxide, bromine vapours, etc., when inhaled in large quantities often choke the throat and cause suffocation. In such a case, move the victim to the open air and loosen the clothing at the neck. The patient should inhale dilute vapours of ammonia or gargle with sodium bicarbonate solution.

6. Fire

- Burning clothes: If clothes have caught fire, then lay the victim on the floor and wrap a fire proof blanket tightly around him. The fire in the burning clothes will thus be extinguished. Never throw water on the person as it will cause serious boils on his body.
- Burning Reagents: In case of fire on the working table, at once turn out the gas taps and remove all things which are likely to ignite. Following methods can be used to extinguish the fire:

    1. If any bottle or beaker containing a liquid has caught fire, cover the mouth of the vessel with a clean damp cloth or duster.
    2. Most of the fire on the working table can be extinguished by throwing water on it.
    3. If any wooden structure has caught fire, it is put off by throwing water on it.
    4. Never throw water on burning oil or spirit. Since it will only spread the fire. Throwing of a mixture of sand and sodium bicarbonate on the fire is most effective.

Self-Check Exercise- 5

List the common accidents that may occur in a science laboratory

2.8 PRECAUATIONS IN SCIENCE LABORATORY

- Take special care with explosives, uncontrolled reactions and inflammable substances.
- Heat inflammable liquid only in round bottomed flasks or steam /bath. Never heat such liquids on naked flames.
- Don't drop lighted matches, sodium or phosphorus into waste boxes.
- Take care that a large round bottom flask does not act as a lens when the sun rays fall on it as it may cause fire.
- Gas supply pipes in physics laboratory should be of non-magnetic material.
- Never use concentrated acids unless specially or specifically instructed.
- Do not mix chemicals aimlessly.
- Do not taste chemicals without permission.
- Pour liquids only down the sink.
- Students should always be followed by the science teacher while working in a laboratory.

Self-Check Exercise- 6

(i) Gas supply pipes in physics laboratory should be of magnetic material. (True/False)

(ii) Students should need not to be followed by the science teacher while working in a laboratory. (True/False)

– **2.9 Summary** Science laboratories play a crucial role at the secondary stage by providing students with hands-on experiences that deepen their understanding of scientific principles through practical application. (National Research Council, 2006; Hodson, 1998). Physical facilities in science, perhaps, are those provisions in schools which facilitate the teacher and pupil to have ideal teaching-learning situations and to utilize them effectively with understanding in a simple and easier way to achieve the desired aims and objectives of science in comparatively less time. It is also to keep the students in touch with the developed advancements in science and to fulfill the individual needs of the students. Acids: Dilute by drinking lots of water or preferably with milk of magnesia.Caustic alkalis: Dilute by drinking water and then drink a glass of lemon or orange juice. For serious cuts call the doctor at once. In the meantime, try to stop bleeding by applying pressure above the cuts. The pressure should not be applied for more than five minutes. Minor bleeding can be stopped easily by applying conc. ferric chloride solution or alum.

2.10 GLOSSARY

Design of science laboratory: This refers to the layout and arrangement of a science laboratory, including factors like the shape of the lab, circulation space, storage areas, placement of permanent equipment, wall space, and provision for demonstration.

2.11 ANSWERS TO SELF-CHECK EXERCISES

Answer to Self-Check Exercise- 1

I. The primary purpose of science laboratories at the secondary stage is to provide students with hands-on experiences that reinforce theoretical knowledge gained in classrooms and to develop practical skills through experimentation (Hofstein & Lunetta, 2004).
II. One essential skill developed through laboratory activities is data collection and analysis. This skill contributes to scientific inquiry by enabling students to gather empirical evidence, analyze results, and draw conclusions based on observed data, thereby fostering critical thinking and understanding of scientific processes (Hodson, 1998).

Answer to Self-Check Exercise- 2

The equipments required in a chemical laboratory are:

- Cupboards (wooden and steel).
- Wall board or black board.
- Demonstration table (8'X4') with cupboards, water and gas points.
- Working tables with cupboards, shelves, water and gas points.
- Balance room should be attached to the laboratory.
- Sinks on each working table or at least two large sinks at the corners of the laboratory.
- A wooden box half filled with sand to be used as a waste material box.
- A full cupboard.
- Acid proof drainage system.
- Shelves for reagent bottle on each working table and wall shelves for storage of reagent bottles.

Answer to Self-Check Exercise- 3

The stock register of chemicals contains the names of chemicals and their description.

Answer to Self-Check Exercise- 4

Four rules to be followed in a laboratory are:

- Students should avoid entering the laboratory in the absence of a teacher.
- Teacher should see that complete silence is observed during the instructions.
- Teacher should make adequate preparation to keep the class busy.
- Adequate apparatus should be made available.

Answer to Self-Check Exercise- 5

Typical accidents that may occur in a science laboratory are:

- Burns
- Cuts
- Eye injuries
- Poison
- Inhalation of Gases
- Fire

Answer to Self-Check Exercise- 6

(i) . False

(ii) False

2.12 REFERENCES/ SUGGESTED READINGS

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2.13 TERMINAL QUESTIONS

1. How will you set up a science laboratory in your school?
2. Discuss the characteristics features of a science laboratory.
3. List various types of audio-visual aids needed in a science laboratory.
4. How are the equipments in physics, chemistry and biology laboratory similar or different from each other?
5. Explain the basic requirements of a science laboratory.
6. What are the guidelines for a science teacher to ensure smooth working in a laboratory?
7. Describe the role of a science teacher in the maintenance of the laboratory records.
8. Mention some common accidents that may happen in a science laboratory and their remedies.
9. What precautions are needed in a science laboratory?
10. Why is a laboratory important for the teaching of science?

UNIT- 3

TEACHING AIDS

STRUCTURE

3.0 INTRODUCTION

Children learn science in various ways, and they grasp it more easily when they are engaged and interested. in it, when it is graphic, when it involves some manipulation on their part, when it is not too hard and when it gives them the satisfaction of having found out something they wanted to know. Thus, those experiences where special effort is not made to memorize something but learning becomes comparatively permanent due to the involvement of senses help in developing concepts. The use of teaching aids is based on the principle that a fact or process is better understood when it is presented through multiple senses.

3.1 1. Learning Objectives

After studying this unit, you will be able to:

- Understand the importance of teaching aids in science
- Categorize various types of teaching aids

- Identify different audio-visual support materials
- Provide examples from different levels of the Cone of Experience
- Select and use appropriate teaching aids for a specific class effectively.

3.2 NEED AND IMPORTANCE OF TEACHING AIDS

In most schools, teaching aids are rarely used to teach science.

. Very rarely, some motivated teachers make personal efforts and show some specimens to students. Usually, children just memorize things without any understanding. Teaching aids if properly used help in teaching learning process in many ways and can ensure quick and effective learning as given below:

- Teaching aids help a learner to achieve learning objectives more effectively.
- Teaching aids create readiness for learning experience in a learner
- Information is clear, precise and accurate when learnt by using teaching aids.
- Teaching aids create visual images which help in long term retention of concepts.
- Depending upon the type of aid used, teaching aids may provide stimulation to senses, real experience and opportunity to the learner to learn at his/her own pace. (Fig. 3.1)

Figure 3.1 Significance of Teaching Aids

Self-Check Exercise 1
List the points related to the significance of teaching aids.

3.3 TYPES OF TEACHING AIDS

Teaching aids can be categorized in various ways based on their characteristics. Four classification types are discussed here:

I. Based on the Sense Organs Involved

Traditional teaching aids typically stimulated only one sense organ, such as the ears or eyes. More modern teaching aids engage both the ears and eyes simultaneously, and many emerging aids also involve other sense organs

Pictorial depiction of this classification is given in Figure 3.2

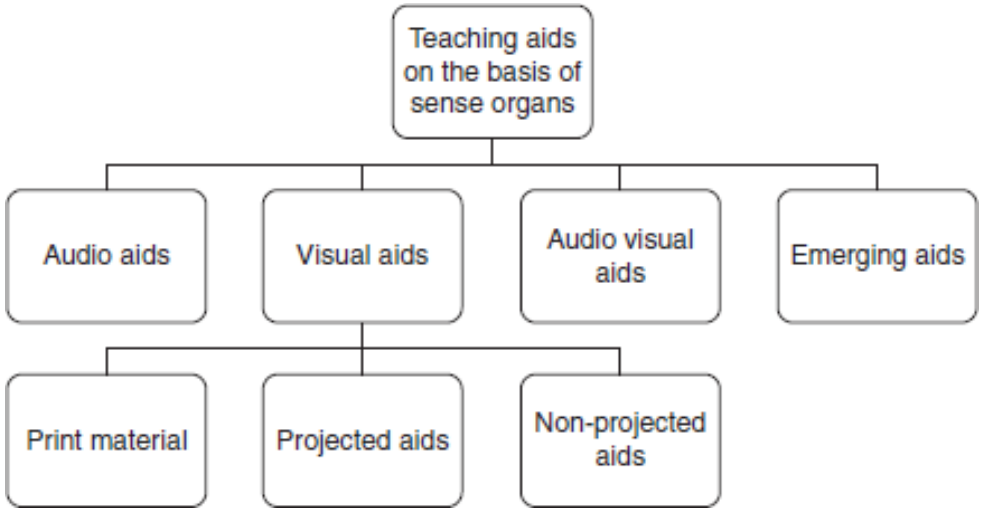

Figure 3.2 Teaching Aids on the Basis of Sense Organs

II. Based on the Size of Learner Groups

Teaching aids can be classified according to the number of students in the class. A learner can be an individual a small group or large groups of individuals. (Fig. 3.3)

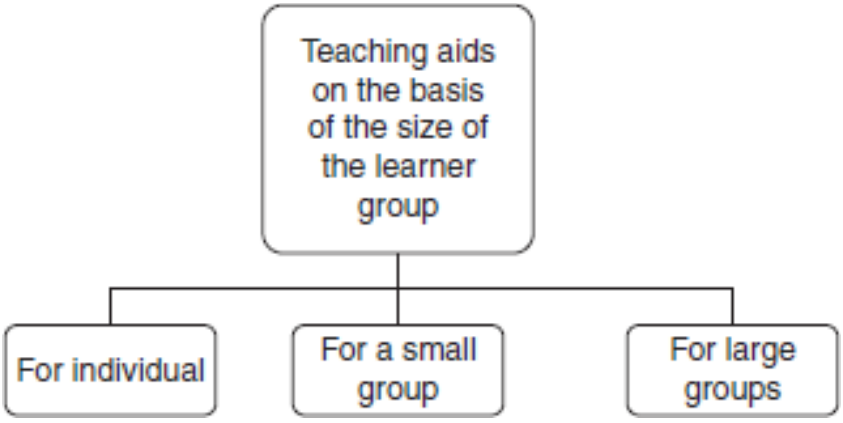

Figure 3.3 Teaching aids based on the Size of the Learner Group

III. **Based on Learners' Control over Teaching Aids**

Some teaching aids are completely in the hands of learners whereas some other depend on many external variables e.g. electricity, infrastructure, etc. Some teaching aids can be controlled by the learner to some extent only. (Figure 3.4).

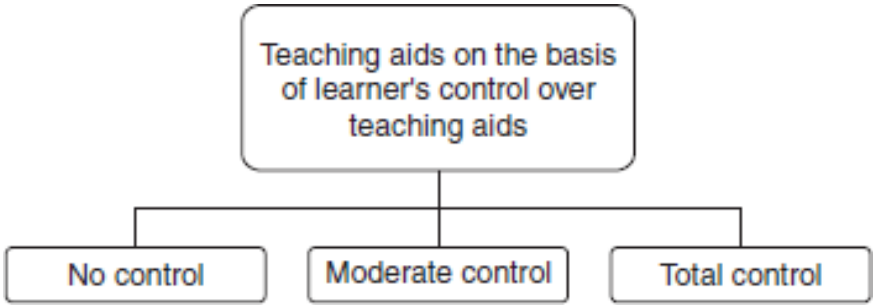

Figure 3. 4. Teaching Aids Based on Learner's Control over the Aid

IV. Based on the Type of Experience Provided by the Aid

Some teaching aids are more concrete, while others are more abstract. The type of experience provided by different teaching aids is illustrated in the Cone of Experience, developed by Prof. Edgar Dale

. (Figure 3.5)

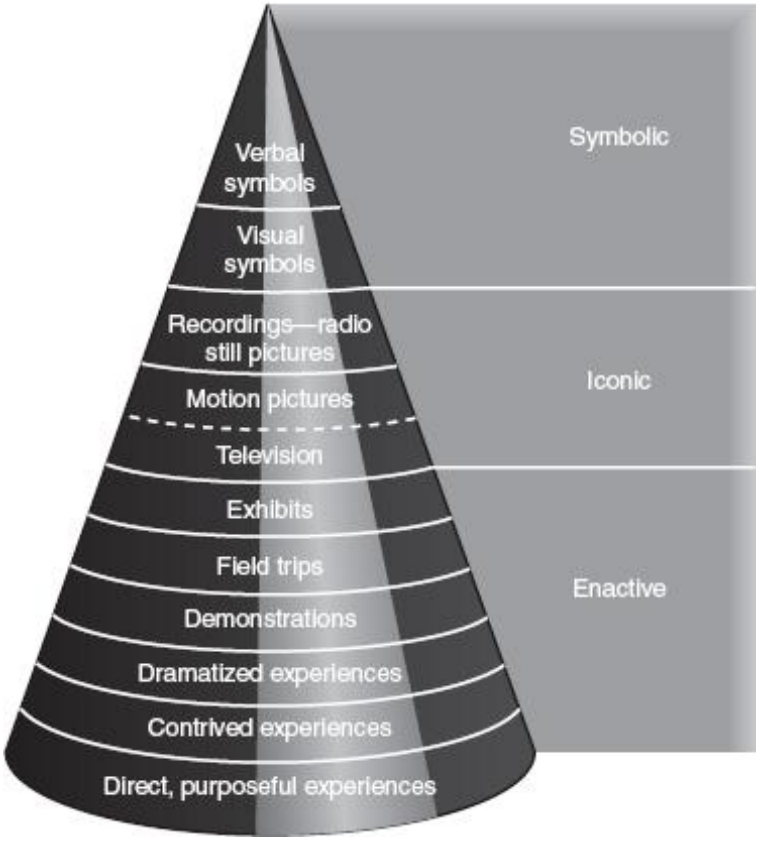

Figure 3.5 Dale's Cone of Experience for Teaching Aids

Self-Check Exercise- 2

(i) Mention the types of teaching aids on the basis of sense organs.

(ii) "CONE OF EXPERIENCE" was given by ……

3.4 Effective Use of Teaching Aids

A wide range of teaching aids is available to science teachers, and it is essential for them to determine which aid will be most appropriate for a specific topic to be taught. Below are some key points that a science teacher should consider before selecting an aid.:

- A teaching aid is not a substitute for teaching.
- An aid should not be very costly.
- Teaching aids should supplement classroom teaching.
- It should be simple and easily understandable.
- Teachers should be able to use the aid effectively.
- It should create interest among students.
- It should not be very time-consuming.
- Teaching aid should fulfil the teaching objectives for a particular topic.

Self-Check Exercise- 3

Mention any two points to be kept in mind by a science teacher before selecting a teaching aid.

3.5 LOW-COST TEACHING AIDS

Low-Cost Teaching Aids

A low-cost teaching aid refers to materials created using simple methods, inexpensive resources, often involving both the teacher and students in the process. These aids can be easily created with little or no budget, making learning more effective, comprehensive, and engaging. A skilled and enthusiastic science teacher can replace many expensive pieces of equipment with suitable, unconventional, or improvised substitutes. The advantage of low-cost teaching aids is that they foster a hands-on, "learning by doing" approach. When teachers and students collaborate to plan, create or create their own educational materials, they take pride in using them to their fullest potential.

Effective science teaching depends on three factors: the teacher, equipment, and materials. Locally produced, low-cost equipment, teaching aids, or models can better serve the needs of both teachers and students and align with the curriculum while being easier to maintain.

Developing Low-Cost Teaching Aids

A teacher's primary responsibility is to create low-cost teaching aids using locally available materials. Teachers should actively participate in the development of these aids, either on their own or with the help of students. To design effective low-cost teaching aids, teachers need to have a strong understanding of the educational objectives and scientific concepts being taught. Additionally, they should be aware of the local resources and environmental conditions. Science teachers who are passionate about their subject often create their own teaching aids using readily available materials. With support from school administrators, parents, and the community, the quality and effectiveness of these low-cost aids can be further improved.

Effective Design of Low-Cost Teaching Aids

When creating low-cost teaching aids, the following basic principles should be followed:

- The concept should be explained clearly and simply to ensure all students can grasp it.
- The aid should capture attention and stimulate critical thinking.
- The aid must be easy to handle and user-friendly.
- It should help save money and avoid the complexities associated with more expensive equipment.

Advantages of Low-Cost Teaching Aids

Improvisation and experimentation are essential for the success of science teaching.

The benefits of using low-cost teaching aids include:

- They enhance knowledge and understanding.
- Improvisation makes science more hands-on and less theoretical.
- It encourages maximum student participation in the learning process.
- It leads to better retention of information.
- It provides firsthand learning experiences in multiple ways.
- It fosters a scientific attitude in students.
- It cultivates a research-oriented mindset.
- It promotes interaction between teachers and students.
- It encourages student interaction and collaboration.
- Improvisation adds interest and engagement to lessons.
- It fosters a cooperative attitude in students.
- It boosts students' self-confidence.
- It enables students to make productive use of their free time.
- It allows the school to become more self-reliant.
- The use of improvised aids makes content delivery more engaging and motivating.
- It supports the introduction of new curriculum ideas.
- It enhances teaching efficiency.
- It accelerates learning and improves retention.
- Learning experiences that engage multiple senses are much more effective than abstract ones.

IMPROVISATION

The preparation and use of relatively low cheap local/readily available materials to teach science or for instruction

IMPORTANCE OF IMPROVISATION

Student learns to handle tools. i.e they develop manipulative skills Science equipments are readily replaceable It is expensive i.eLow-cost materials are used It enables the students to be involved in practical activity at the same time It is used in place of dangerous/sophisticated /unavailable equipment It helps appreciate discarded scrap or materials It makes science learning interesting It makes the teacher resourceful

DISADVANTAGES

Crude materials are not standard/modern Results will be affected Learners will not be abreast with the use of modern equipment Requires a resourceful teacher Time consuming in its preparation Principles Involved In Improvisation The function and working principles involved Where and how to get bit and pieces needed for improvisation The need to co-operative with some local craftsmen for example, carpenters fitters etc. Does the improvised material work? Does it suite the level of the children? Is the improvised material safe? Are materials readily available?

TYPES OF IMPROVISATION

1. Improvisation by substitution

2. Improvisation by construction

IMPROVISATION BY SUBSTITUTION

This means using improvised material in place of real or original materials. For example, using clean cloth in place of filter paper is a form of improvisation by substitution

IMPROVISATION BY CONSTRUCTION

This means constructing improvised materials to operate just as the original one to perform the same function as the original one. Example constructing beam balance in place of the original one, construction of a circuit board, construction of beaker measuring cylinder etc

SOME SUGGESTED IMPROVISED MATERIALS FOR TEACHING SCIENCE IN BASIC SCHOOLS

No.	Materials	Improvised Materials
1	**Filter**	Paper Cotton wool/cloth/cement paper
2	**Beam balance**	Make two scale pans from coffee tin lids or plastic pipelines. Hang these by thread at the ends of a cloth hanger. Hang the hanger by its hook on a nail
3	**Delivery tube**	Infusion tube boiled for 15 minutes before use
4	**Magnifying glass or hand lens**	Pick used transparent electric bulb, break off the metal and remove the inner glass which holds the filament. Wash and fill with water and use to observe things. Other things that can be used are spectacles, a clear bottle, a beaker
5	**Concave mirror**	Use steel wool or metal polish with cotton to polish thoroughly the bottom part of an empty canned drinks e.g. Fanta , Coke etc
6	**Beaker and funnel**	Get a transparent plastic bottle and cut through its circumference (2/3 way of its height). Use bottom portion as beaker and top portion as funnel
7	**Indicators**	Detach and grind some petals of flowers. Add water to the ground pulp , boil it for some few minutes. Allow to settle on cooling and filter solution. Dyes a filter paper with solution allow drying and using as litmus paper for acid and alkaline tests.
8	**Acids**	Extract juices of lime, lemon or tomato and use as acids. Also one can use vinegar, acids from car batteries
9	**Rubber stopper or corker**	These can be cut from discarded bathroom sandals, corn stalk cob, bamboo or raffia palm stalk etc. By cutting them to be required shape
10	**Magnets**	Get magnets from old discarded radio speakers, magnetized bar metals. Wind round a nail (15cm long) an insulted copper wire, connect a dry cell to its terminals and use it to pick tiny magnetic substances such as office pins, small nails etc.

The Role of the Teacher in the Improvisation Process
It is crucial to understand that the process of improvising materials is not solely for

teachers, students can be also involved effectively in the process such as collecting things from different sources, assigning tasks for them to produces learning materials etc. Thus, in the process of improvising teaching/learning materials teachers may play different role.

Self-Check Exercise- 4

Explain the basic principles to be followed while preparing low-cost teaching aids.

3.6 Summary The teacher should take an active role in preparing low-cost teaching aids, either independently or with the assistance of students. To design effective low-cost teaching aids, the teacher must have a thorough understanding of the objectives and scientific concepts being taught. Additionally, teachers should be well-versed in utilizing available resources and considering local environmental conditions to enhance the learning experience. Very rarely, some motivated teachers make personal efforts and show some specimens to students. Usually, children just memorize things without any understanding. Teaching aids help a learner to achieve learning objectives more effectively. Teaching aids create readiness for learning experience in a learner Information is clear, precise and accurate when learnt by using teaching aids.

3.7 GLOSSARY

Teaching aids: Teaching aids are basically the tools, materials, equipments and resources used by a teacher in his classroom to facilitate the teaching-learning process and engage students actively. Example of teaching aids include charts, models, video and presentations, etc.

Improvisation: In education, improvisation involves creating or utilizing alternative materials, tools, or methods to meet educational objectives

3.8 ANSWERS TO SELF-CHECK EXERCISES

Self-Check Exercise- 1

Importance of teaching aids:

- Achievement of learning objectives.
- Readiness in the learners.
- Stimulation to senses and real experience.
- Clear, precise and accurate information.
- Creation of visual images.

Self-Check Exercise- 2

(i) Classification of teaching aids on the basis of sense organs:

- audio aids

- visual aids: print material, projected aids, non-projected aids.
- audio-visual aids
- emerging aids

(ii) Edgar Dale

Self-Check Exercise- 3

Teaching aids should complement classroom instruction, and teachers must be able to use them effectively

Self-Check Exercise- 4

Basic principles to follow when preparing low-cost teaching aids:

- The concept should be explained in a clear and simple manner, ensuring that all students can understand the material
- It should capture attention and encourage critical thinking.
- The low-cost teaching aids should be straightforward and easy to use.
- Significant cost savings can be achieved, while avoiding the complexities of more sophisticated equipment.

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3.10 TERMINAL QUESTIONS:

1. Explain the importance of using teaching aids in science education.
2. How are teaching aids utilized in science instruction?
3. Explain the various types of teaching aids that can be used in science instruction.
4. What is the importance of motion films in science education?Name different types of projectors and their uses.
5. What precautions should be taken before selecting a teaching aid?

UNIT- 4

E-LEARNING RESOURCES AND SMART CLASSROOM

STRUCTURE

4.0 INTRODUCTION

Electronic resources are considered a vast repository of information accessed through modern ICT devices. This information is often refined, redesigned, and stored in cyberspace in a highly compact and concrete format, making it accessible simultaneously from numerous points by many users.

4.1 LEARNING OBJECTIVES

After studying this unit, you will be able to:

- Understand the importance of e-learning resources.
- List the various e-learning resources.
- Know Indian Initiatives of Open Educational Resources.
- Identify audio-visual support materials.
- Understand the concept of smart classroom.

4.2 E-LEARNING RESOURCES

An E-resource refers to materials that require computer access, whether through a personal computer, mainframe, or mobile device. E-resources provide instant access to information, offering up-to-date and fast data. These resources include E-JOURNALS, E-BOOKS, E-PAPERS, E-IMAGES, E-DATABASES, E-AUDIO, E-MAGAZINES, the WWW, CD-ROMs, E-THESIS, E-RESEARCH REPORTS, HELP AND TUTORIALS, and DIGITAL REPOSITORIES. E-resources are part of the "Invisible Web," which consists of online information not typically indexed by standard search engines like Google.

E-resources are digital documents made available to library users through computer-based information retrieval systems. The internet serves as the primary means of accessing most e-resources, through search engines like Google, AltaVista, MSN, Yahoo, and WebOPAC. Additionally, some offline databases in CD/DVD formats can be accessed without an internet connection. As such, e-resources include online databases, web page content, e-journal articles, electronic personal papers, e-mail messages, newsgroup postings, newsletters, government publications, e-theses and dissertations, e-newspapers, CDs/DVDs, e-books, and e-databases

HTML links, digital library materials, institutional repositories, social networks, open access materials, and more.

Self-Check Exercise- 1

Write some examples of e-learning resources.

4.3 TYPES OF E-RESOURCES

A. E-Journals

Electronic journals, also known as e-journals or electronic serials, are scholarly publications that can be accessed through computer and communication technology, typically via the web. These specialized electronic documents provide material for academic research and study, formatted similarly to traditional printed journal articles. E-journals can be divided into online-only journals, online versions of printed journals, or digital equivalents of printed journals. Most commercial e-journals are subscription-based or offer pay-per-view access. Many universities subscribe to bulk packages of e-journals, providing access to students and faculty, while some journals are now available as open access, offering free full-text articles.

B. E-Books
An e-book, also referred to as an electronic book or digital book, is a publication in digital format that includes text, images, or both. E-books are typically read on e-book readers, tablets, personal computers, or smartphones using e-reader applications. They are often purchased and downloaded online, much like other digital products. E-book formats have gained broad support from major software platforms companies like Adobe (with its PDF format) and various open-source programmers.

C. E-Magazines
An e-magazine is a digital version of a traditional magazine, published on the World Wide Web. Some online magazines use the term "electronic" or "e-magazine" to appeal to their readership or to capture alternative search terms. Many major print publishers now offer digital versions of their print magazines through online services for a fee. These digital collections are often referred to as online magazines or digital magazines.

D. E-Database
An e-database is an organized collection of information on a specific topic, accessible and searchable electronically. E-databases are regularly updated and can be managed on a daily, weekly, monthly, or quarterly basis. They can be classified into full-text databases, which provide complete texts of books, articles, and other documents, and bibliographic databases, which provide citation details like author names, journal titles, publication dates, and page numbers.

E. World Wide Web
The World Wide Web is a system of interconnected hypertext documents accessible via the internet. Using a web browser, users can view web pages that contain text, images, videos, and other multimedia, navigating between them via hyperlinks. The Web differs from previous hypertext systems by utilizing unidirectional links, allowing one resource to link to another without requiring action from the owner of the linked resource. Viewing a web page begins by typing a URL into the browser or following a hyperlink, prompting the browser to retrieve and display the page.

F. CD-ROM
CD-ROM stands for Compact Disc Read-Only Memory, a non-volatile optical disc that stores large amounts of data, typically up to 650 MB, with some discs storing up to 1 GB. CD-ROMs are similar to audio CDs and can store data accessed in a similar manner. Made of polycarbonate plastic with a thin aluminum layer for reflection, CD-ROMs are commonly used to distribute computer software, including video games and multimedia applications, and can store various types of data, sometimes including both computer data and audio.

G. E-Thesis
An e-thesis is a digital version of a thesis that can be accessed online. E-theses are often stored in open-access repositories, such as the UCC (Uniform Commercial Code) institutional repository, CORA, ensuring that postgraduate research is widely available. In many countries, electronic thesis submission is now a common practice alongside hard-copy submissions, making theses searchable and accessible online.E-theses are stored in repositories like CORA, which uses DSpace software

and does not impose a file size limit, although Google Scholar only indexes PDF files under 5MB.

Self-Check Exercise- 2

An e-book is also known as _____

4.4 Indian Initiatives in Open Educational Resources (OER)

Indian OERs can be broadly categorized into audio-visua and textual resources. Some of these initiatives are aimed at school students, while the majority focus on students in technical and vocational education and training (TVET), higher education, and lifelong learning.

A few notable Indian OER initiatives include:

- **National Programme on Technology Enhanced Learning (NPTEL)** (www.nptel.iitm.ac.in/)
- **Learning Object Repository of the Consortium for Educational Communication (CEC)** (www.cec-lor.edu.in/)
- **Project Open Source Courseware Animations Repository (OSCAR)** (http://oscar.iitb.ac.in/; http://ekalavya.iitb.ac.in/oscarHome.do)
- **eGyanKosh of Indira Gandhi National Open University (IGNOU)** (http://in.youtube.com/IGNOU)
- **Online Textbooks of the National Council of Educational Research and Training (NCERT)** (www.ncert.nic.in/html/textbooks.htm)
- **National Science Digital Library (NSDL) of the National Institute of Science Communication and Information Resources** (http://nsdl.niscair.res.in/)
- **Vidyanidhi** – A digital library and e-scholarship portal for theses and dissertations (www.vidyanidhi.org.in/)
- **Rai OpenCourseware** (www.rocw.raifoundation.org/)

In addition to these, various other e-resources are available in the form of digital libraries, institutional repositories, open access resources, journals, and more

.

Self-Check Exercise- 3

(i) Write the full form of OER.

(ii) Write the full form of NPTEL.

4.5 AUDIO-VISUAL SUPPORT MATERIAL

I. Educational Television: In most states, school television relays programmes based on the syllabus. A telecast schedule is provided to schools. State Institutes of Educational Technology and Central Institute of Educational Technology, New Delhi produce educational T.V. programmes which are not syllabus based. Rather, they are on general topics of interest to enable enjoyable learning. Besides these two programmes, UGC's countrywide classroom is another educational telecast. Although these programmes are for college students, secondary both students and teachers at various levels can also benefit from them. National Network relays some educational programmes such as Quest, Turning Point, etc. Discovery channel, Nat Geo, Animal Planet telecast exclusively educational programmes.

Students should be exposed to such educational programmes and motivated to watch them.

II. Radio Recordings and Still Pictures

Radio programmes: All India Radio broadcasts radio programs for schools in several states. A copy of the schedule is sent to schools so that the school time-table can be planned accordingly Radio programs can be utilized either during live broadcasts or recorded for later use. This category also includes audio cassettes. Audio programs are produced by the Central Institute of Educational Technology and the State Institute of Educational Technology and Educational Technology Cells of SCERT. Audio programmes should be prepared on those topics which can be understood verbally.

III. Projectors

Projected pictures need projectors for their display. Some common projectors used are (Figure 4.1)

Slide projector

Overhead projector

Opaque projector

Micro projector

Figure 4.1 Types of Projectors

1. Slide projector: Slide projectors are of two types—manual or automatic. For slide show, a dark room is needed, and since it is visual only, commentary is also required.
2. Overhead projector: It is the most convenient and effective medium. Here, drawings on transparent sheets are enlarged and projected through lens on to a white screen.
3. Opaque projector: This projector is used to enlarge and show some illustration directly from a book, magazine, etc. Any written or printed material can be projected. Opaque thin objects like leaves, moths, fabrics, etc. can also be projected.
4. Micro projector: It enlarges images of stained sections of microscopic slides or other mounted images. Many times, students don't understand diagrams or slides through a microscope as they view them without any explanation. In such cases, a micro projector can be used to illustrate the images to large groups of students together.

Self-Check Exercise- 4

(i) Mention different types of projectors used in classrooms.

(ii) Radio programs for schools are broadcast by All India Radio in various states.

4.6 SMART CLASSROOMS

Smart classrooms combine technology used at the teacher's desk with that in front of the classroom. A smart classroom is defined by both the available technology for students and the physical environment that supports its effective use. Simply adding smart boards, laptops, tablets, and other devices to a classroom does not automatically make it "smart." These tools are integral to the classroom, but when used effectively, they can greatly enhance learning outcomes for all students. The level of engagement from learners is influenced by the entire classroom environment, including infrastructure, teaching methods, hardware, and software. When these elements work together, they create an optimal learning space, often called a smart classroom. This approach involves all stakeholders in the learning process and emphasizes collaboration within both physical and virtual spaces. The model focuses on the teacher guiding students through a dynamic learning journey, rather than merely delivering information in a one-way, linear fashion.

Definition of Smart Classrooms

Northwestern University defines smart classrooms as...

"... technology enhanced classrooms that foster opportunities for teaching and learning by integrating learning technology, such as computers, specialized software, audience response technology, assistive listening devices, networking, and audio/visual capabilities."

In India, the Smart Class initiative was launched by EDUCOM in 2004. Initially, a soft launch in select regions demonstrated remarkable acceptance among private schools of various categories. The program was developed with the belief that for technology to become an essential part of daily teaching and learning practices, it must be integrated directly into the classrooms, where learners and instructors spend 80% of their time. Early adopters included prestigious Indian schools such as Takshila, DPS Pitampura in Delhi, and the Cambridge Chain of Schools. Today, the program has been adopted by over 1,000 schools across India, playing a significant role in the rapid integration of technology into classrooms nationwide. (Corporate Diary, 2007).

A smart classroom is one where the instructor is equipped with computer and audio-visual technology, allowing them to teach using a wide range of media. These include interactive whiteboards, DVDs, PowerPoint presentations, and more, all projected through a data projector. The Smart Class initiative, developed by EDUCOMP, is transforming the traditional teaching and learning process. By integrating technology directly into the classroom alongside the blackboard, Smart Class makes learning more engaging for students and enhances their overall academic performance.

Smart Class features a unique delivery model for schools, which includes creating a knowledge center within the school, equipped with a library and digital content. This knowledge center is connected to classrooms via the internet. Teachers can access relevant digital resources such as animations, videos, and virtual lab tools to enhance their lesson plans for every class. Classrooms are equipped with custom-designed interactive whiteboards, projection systems, and PCs. EDUCOMP implements the Smart Class program on a turnkey basis, charging on a per-student or per-month basis.

The program is supported by a vast repository of digital instructional materials, carefully aligned aligned with the specific goals of various state learning standards. This content library is continuously updated through the development of Educomp's digital solutions. The repository contains thousands of animated, lesson-specific multimedia modules in 2D and 3D, designed for both teacher-led and student-centered learning. Modules assist students in understanding concepts more easily and engaging with their peers, enhancing the learning experience to be both enjoyable and effective.

Educomp has collaborated with international content providers like Discovery Education, Design Mate Eureka, and Crocodile Clips, adding world-class digital content, 3D educational videos, and interactive virtual lab software to its repository. These resources allow teachers to deliver lessons effectively, with visuals that are engaging and instructional, while allowing them to control the pace of the lesson.

The curriculum ranges from kindergarten to 12th grade and includes subjects like mathematics, science, English, social studies, and more. Teachers can also create customized tests for assessment, using a special tool within the Smart Class system. Students are provided with handheld remote devices to answer questions during class. At home, the Smart Class system functions as a virtual school, allowing parents, teachers, and students to communicate. Teachers can upload assignments and share important information with parents.

Smart classrooms offer a solution to common learning challenges. By providing audio-visual presentations, students receive a richer sensory experience, which enhances their understandingA study conducted by the Eugene Research Institute revealed that 5th graders in smart classrooms were 60% more likely to meet state reading benchmarks compared to their peers who were not part of smart classrooms. Research by Lincoln (1992) and Glasser (2001) supports the notion that students gain a much deeper understanding when they experience content firsthand rather than just reading about it.

Smart classrooms promote improved reading skills and academic performance, with studies indicating that interactive learning methods in these environments enhance students' overall learning outcomes. comprehension and retention of complex concepts. Research by Trifonas (2004) highlights that students can better decode and understand material through both lexical and visual cues. Additional studies, such as those by Sevindik (2007) and D and B Street Information Service India Pvt. Ltd. (2010), demonstrate the positive impact of Smart Class programs on academic achievement, particularly in terms of comprehension and the retention of knowledge. The program has a notable impact on generating curiosity and improving time management for teachers.

Advantages

- Introduction of concept in a thrilling and exciting manner.
- A student's better engagement with the content on a smart board is dynamic and visually more appealing.
- Storage of teachers written notes.
- Voice recording is possible.
- Teaching skills can be enhanced by showing various videos to the students.
- Scope for the integration of different types of technology and other novel ways to the teachers to present lesson.

- Teachers are able to keep students engaged in the learning process and also get an instant and accurate assessment of learning outcomes achieved at the end of the class.

Self-Check Exercise- 5

In India, Smart class was launched by EDUCOM in 2004. (True/False)

4.7 Summary

A smart classroom is one where the instructor is equipped with computer and audio-visual tools, enabling the use of various media for teaching. These tools include interactive smart whiteboards, DVDs, PowerPoint presentations, and more, all projected through a data projector. Smart Class is a digital initiative by EDUCOMP that is transforming the way teachers teach and students learn. By integrating technology into the classroom alongside the traditional blackboard, Smart Class enhances the learning experience, making it more engaging for students and improving their academic performance.

A telecast schedule is provided to schools, where educational TV programs produced by the State Institutes of Educational Technology and the Central Institute of Educational Technology in New Delhi are available. These programs are not strictly syllabus-based but focus on general topics of interest that facilitate enjoyable learning. Additionally, the UGC's Countrywide Classroom provides another educational telecast. E-theses are stored in CORA, the institutional repository of the University College Cork (UCC), which is an open-access platform based on DSpace software. There are no file size limits for e-theses stored in CORA, although Google Scholar can only index PDF files smaller than 5MB.

Glossary

- **E-resource**: Digital materials requiring computer access, whether through a personal computer, mainframe, or mobile device, providing up-to-date and quick information.
- **E-Journals**: Digital versions of academic journals that can be accessed electronically.
- **Institutional Repositories**: Digital archives containing an institution's intellectual output.
- **Smart Classrooms**: Classrooms that combine technology at the teacher's desk and in front of the classroom, with technology in the hands of the students and an environment that enables the effective use of that technology.

4.9 ANSWERS TO SELF-CHECK EXERCISES

Self-Check Exercise- 1

Examples of e-learning resources are: e-journals, e-books, e-paper, e-image, e-database, e-thesis, digital repository, etc.

Self-Check Exercise- 2

Electronic book, digital book and e-edition.

Self-Check Exercise- 3

(i) Open Educational Resources.

(ii) National Programme on Technology Enhanced Learning.

Self-Check Exercise- 4

(i) Different types of projectors used in the classroom are:

- Slide projector
- Overhead projector
- Opaque projector
- Micro projector

(ii) All India Radio

Self-Check Exercise- 5

True

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4.11 TERMINAL QUESTIONS

1. What do you mean by Audio-Visual Support Material? Give some examples.
2. What do you mean by e-learning resources?
3. Define Smart Classroom. Explain its advantages.

Unit-5

Unit Planning

Structure:

5.1-Introduction:

The unit approach is associated with the name of Professor H.C. Morrison of the University of Chicago. Morrison has explained the unit method in detail in his book. "The practice of Teaching in secondary schools", A unit may be defined as means of organising materials for instructional purpose which utilises significant subject-matter content, involves students in learning activities through active intellectual and physical participation, leading to a change in their behavior, enabling them to handle new problems and situations more effectively

5.2Learning Objectives: After reading this chapter, students will be able to understand:

- The meaning, definitions, and characteristics of unit planning.
- The steps involved in unit planning.

5.3 Unit Planning: To simplify and clarify classroom teaching, the syllabus is divided into distinct units, each of which forms the basis for lesson planning. Based on these units, the content is organized into several lessons, and teaching is carried out accordingly. Each lesson is a component of the unit, contributing to the development of the next lesson.

Definition:

Preston defines a unit as: “A unit is as large a block of related subject matter as can be over-viewed by the learner.”

Preston also states: "A unit is a part of related content that is assimilated by a student within a specific period."

According to Bossing: “A unit consists of a comprehensive series of related and meaningful activities to achieve the pupil’s objectives, provide significant educational experiences, and re**Characteristics of a Good Unit:**

1. The objectives should be clear and well-defined.
2. The teaching aids used should be clearly identified. According to Hanson, "A variety of materials is almost essential for the teaching process to help the class achieve its objectives."
3. A good unit should include provisions for evaluation and follow-up activities.
4. A well-organized unit is always a complete and integrated whole.
5. A good unit provides opportunities for student engagement, ensuring they are active participants in their learning.
6. It should relate to the students' lives and connect to other subjects.
7. A good unit is designed to be within the students' level of understanding.
8. It should consider individual differences among students.
9. It should include room for field trips, projects, practical work, and demonstrations in appropriate behavioral changes.”

5.3.1Characteristics of a Good Unit:

1. The objectives should be clear and well-defined.
2. The materials and aids used should be clearly identified. As Hanson states, “A variety of materials is almost essential for the teaching process to help the class achieve its objectives.”
3. A good unit should include provisions for both evaluation and follow-up.
4. The unit should be well-organized, functioning as a complete and integrated whole.
5. A good unit should incorporate activities that engage students, ensuring they are active learners rather than passive recipients of information.
6. The unit should be relevant to students’ lives and connect with other subjects.
7. It should always be appropriate for the students' level of understanding.
8. The unit should accommodate individual differences among students.
9. It should provide opportunities for field trips, projects, hands-on work, and demonstrations

.

Self-Check Exercise-1
Q1. What is a unit plan?
Q2. True or False: The content is arranged in several lessons, and teaching is conducted according to the unit planning.

5.3.2: Advantages of Unit Planning:

1. It helps clarify both the general and specific objectives of teaching.
2. The teacher can address the diverse needs, abilities, and attitudes of students.
3. It encourages a collaborative and democratic environment where both students and the teacher work together.
4. It saves time and increases student engagement, as they recognize the importance of the material being taught.
5. It fosters the development of various skills and enhances students' critical thinking.
6. Students can apply the knowledge gained in real-life situations.
7. As students learn independently, it builds their confidence, resourcefulness, and self-reliance.

5.3.3: Steps in Unit Planning:

1. **Preparation:** This step engages and motivates students, maintaining their interest and enthusiasm throughout the learning process.
2. **Assessment of Prior Knowledge:** A unit should start by evaluating where the students currently stand. The teacher should assess their existing knowledge before moving forward.
3. **Presentation:** The content is introduced to students using various aids and relating it to their prior experiences. This phase connects new learning with previously acquired knowledge.
4. **Summarization:** At the conclusion of the unit, a summary of the key content is provided, with additional sectional summaries if necessary.
5. **Review or Recapitulation:** This step revisits and reinforces the facts discussed, giving students an opportunity to review the entire unit.
6. **Evaluation:** This vital step helps the teacher assess the extent of students' learning and identify any gaps that need to be addressed, often through tests, questionnaires, or other methods.

Self-Check Exercise-2
Q1. Write the steps of unit planning.
Q2. True or False: The teacher cannot cater to the needs, aptitudes, and attitudes of different students.

5.4 - Summary:

To be effective, a lesson plan does not need to be an exhaustive document detailing every possible classroom scenario. Nor does it need to predict every student’s response or question. Rather, it should offer a general outline of teaching goals, learning objectives, and strategies to achieve them. It serves as a reminder of what you want to do and how you intend to do it.

5.5 Glossary

Unit: It is a component of study which forms part of any course.

Plan: A detailed proposal for doing or achieving something.

Summarization: It is a shortened version of written material that presents the central ideas and key points expressed in writing.

Recapitulation: An act or instance of summarizing and restating the main points of something.

5.6 Answers to Self-Check Exercise

Self-Check Exercise-1

Ans1. A unit plan may be defined as means of organising materials for instructional purpose which utilises significant subject- matter content, Involves students in learning activities through active intellectual and physical participation, and alters their behavior to the point where they can handle new problems and situations more effectively.

Ans2. True

Self-Check Exercise-2

Ans1. 1. Preparation

Ans2. False

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5.8-Terminal Questions:

1. Discuss the meaning and concept of unit planning.

2. What are the steps of unit planning? Describe the characteristics of unit planning.

Unit-6

Lesson Planning, Approaches of lesson planning

Structure:

6.8 Glossary

6.9 Answers to Self-Check Exercise

6.10- References and suggested readings

6.11- Terminal questions

6.1-Introduction:

Teaching is a process that encompasses the various activities a teacher carries out in the classroom. It is grounded in planning, specifically lesson planning. A lesson plan is a detailed strategy prepared by the teacher in advance for daily instruction. It aids the teacher in delivering systematic and effective lessons. The Herbartian approach, based on the apperceptive mass theory of learning, suggests that learners are like a blank slate, and all knowledge is imparted to them externally. When new information is connected to the learner's prior knowledge, it is more easily understood and retained for a longer time. The content should be divided into units and arranged in a logical sequence. A lesson plan serves as an outline, listing the key points of a lesson in the order they will be presented. It may include objectives, main points, questions to ask, reference materials, assignments, and more.

6.2-Learning Objectives: After reading this chapter, the learners will be able to know about:

Meaning, importance and steps of lesson planning

Approaches of lesson planning

6.3- Lesson planning: -

6.3.1 Meaning and Importance of Lesson Planning:

Carter V. Good defines a lesson plan as "a teaching outline of the key points of a lesson arranged in the order in which they are to be presented. It may include objectives, questions to ask, references to materials, assignments, etc." According to Bossing, "A lesson plan is an organized statement of general and specific goals, along with the specific methods to achieve these goals under the teacher’s guidance on a given day." Essentially, a lesson plan outlines the actions the teacher needs to take in the classroom. For teaching to be effective, successful, and impactful, a lesson plan is indispensable. Much like a skilled craftsman, a teacher must plan their tools and techniques to guide their teaching, allowing their creativity and teaching talents to shine. As is often said, "A lesson plan is the teacher’s mental and emotional visualization of classroom activities."

6.3.2: Advantages of Lesson Planning:

1. Ensures a clear aim for each day’s work.

2. Boosts the teacher’s confidence, as they’ve already addressed potential challenges and solutions.
3. Prevents time wastage, as the teacher has a systematically organized plan, ensuring smooth progression without confusion.
4. Ensures the timely and appropriate use of teaching aids.
5. Guarantees that assignments are tailored to the students' cognitive levels.
6. Assists the teacher in determining the most effective teaching method for the lesson.
7. Stimulates the teacher to pose relevant questions and engage students effectively.

6.3.3: Characteristics of a Good Plan:

1. Clarifies the objectives of the lesson for the teacher.
2. Helps the teacher to systematically present subject matter, arranging activities in a logical order, addressing questions, and preparing for potential issues.
3. Assists in selecting the right motivational techniques and teaching aids.
4. Should be flexible to accommodate adjustments.
5. Always written for clarity and reference.
6. Acts as a guide for the content, methods, activities, and aids used.

6.3.4: Steps Involved in a Lesson Plan:

Herbart’s Six Formal Steps (Herbartian Steps) for lesson planning are:

1. **Preparation:** The teacher should first prepare the students for new knowledge, generating interest and setting the stage for learning.
2. **Presentation:** The subject matter should be presented clearly and in a familiar manner, involving active participation from the students. Relevant questions should be asked, with aids and “Blackboard summaries” integrated into the lesson.
3. **Comparison:** Students contrast what they learn with similar examples to enhance their understanding.
4. **Generalization:** Students participate in formulating generalizations based on the lesson’s content.
5. **Application:** The acquired knowledge should be applied to new situations, allowing students to transfer what they've learned to various contexts.
6. **Recapitulation:** The final step involves reviewing the lesson’s content to check students' understanding and the teacher’s success in achieving the lesson's goals.

6.3.5: Strategy for Preparing a Good Lesson Plan:

A lesson plan acts as a guide for what students need to learn and how it will be taught during class. Before creating the plan, teachers should define the learning objectives for the session. A well-structured lesson plan includes these three key components

- Clear learning objectives
- Engaging teaching/learning activities

- Methods for checking student understanding

By defining concrete objectives, the teacher can then choose the appropriate activities and strategies to assess whether the objectives are met.

6.3.6Steps for Creating a Lesson Plan

Here are six steps for developing effective lesson plans, each with guiding reflection questions:

1. **Define Learning Objectives:**
   - What is the main topic of the lesson?
   - What should students learn and be able to do by the end of the session?
   - What key concepts should they take away?
2. **Design the Introduction:**
   Begin by assessing students' prior knowledge of the topic. Use questions or quick surveys to gauge their existing understanding, which will help direct the lesson.
3. **Plan Specific Learning Activities:**
   Prepare various teaching methods (e.g., real-life examples, visuals) to accommodate different learning styles. Estimate the time required for each activity and remain flexible in case adjustments are needed based on student comprehension.
4. **Plan for Assessing Understanding:**
   Decide how you will evaluate whether students grasp the material. What questions will you ask to check their understanding? Consider multiple approaches to assess their grasp of concepts and plan how they will demonstrate their learning.
5. **Conclude and Preview the Next Lesson:**
   Summarize the key points of the lesson and preview what will be covered next to maintain continuity and engage students in upcoming material.
6. **Establish a Realistic Timeline:**
   Outline the time for each activity, leaving space for questions and discussions. Build flexibility into the schedule to allow for adjustments based on students' responses.

Presenting the Lesson Plan:

Sharing the objectives and activities with students at the start of the lesson helps keep them engaged and focused. A clear outline, whether on the board or as a handout, ensures students are aligned with the lesson's goals.

Reflecting on Your Lesson Plan:

After each class, take time to reflect on what worked well and what could be improved. Consider adjustments to enhance future lessons improved. This feedback loop allows teachers to adjust and refine their methods for better outcomes in future lessons. Tools like student feedback, peer observation, and video reviews can further support the teacher's growth and development.

Self-Check Exercise-1

Q1. What is a lesson plan?

Q2. …….formal steps are suggested by J.F. Herbart in lesson planning.

6.4-Approaches of Lesson Planning: The approaches of lesson planning are discussed as below:

6.4.1 Herbartian Approach to Lesson Planning:

John Frederic Herbart, a prominent 19th-century European educator and philosopher, emphasized the importance of active planning in teaching to ensure its effectiveness. His approach is firmly grounded in applying psychological principles to the learning process.

The Herbartian approach is built on the Apperceptive Mass Theory, which posits that learners begin as "blank slates."and all new knowledge is imparted from external sources. For knowledge to be retained longer and understood more easily, it must be linked to the learner's prior knowledge. This theory recommends that content should be divided into logical, manageable units, and these units should be arranged sequentially.

Drawing from educational psychology, Herbart's teaching philosophy he proposed four key elements for effective teaching:

1. **Interest**: Teaching should capture the students' attention. When students are engaged, they are more focused and better able to absorb information.
2. **Apperception**: Learning takes place when new information is linked to what the learner already knows, making the process easier. Teachers should build upon familiar concepts before introducing new ones to create these connections.
3. **General Method**: Learning activities should be organized in a clear, logical order, allowing students to make connections between facts and concepts.
4. **Correlation**: Subjects should be taught as interconnected, creating a unified body of knowledge. Teachers should relate content from different disciplines to provide a more integrated learning experience.

6.4.2: Steps in Teaching Approach

Herbartian teaching involves specific steps to facilitate the learning process:

1. **Clarity**: Teachers should present the subject matter clearly, breaking it into manageable pieces for the students to focus on.
2. **Association**: New information should be linked to the students' existing knowledge to help them absorb and understand it more effectively.
3. **System**: New concepts should be structured in a logical manner, allowing students to recognize connections between different facts and develop a well-rounded understanding
4. **Method**: Students should apply the knowledge gained to new situations, testing its practical application.

6.4.3: Herbartian Five-Step Teaching Model

Although Herbart proposed four steps, his followers, like Ziller, modified the approach. Ziller split the "clarity" step into two parts: **Introduction** and **Presentation**, while Ryan added a new step, the **Statement of Aim**, between these two. Other modifications resulted in the five steps now commonly known as the Herbartian Five-Step Teaching Method:

1. **Preparation/Introduction**: The teacher stimulates student interest by evaluating their prior knowledge with questions, piquing their curiosity and setting the stage for new content.
2. **Statement of Aim**: The teacher clarifies the lesson's objectives to the students, often writing them on the board.
3. **Presentation**: The lesson is developed with student involvement. The teacher asks questions to encourage active participation, helping students relate new knowledge to what they already know.
4. **Comparison and Association:** The teacher links new facts and concepts by comparing them to previously learned material, strengthening students' understanding.
5. **Generalization:** After the lesson, students are encouraged to develop principles and rules that they can apply to different future scenarios.

6. **Application:** The teacher evaluates whether students can transfer the knowledge to new situations, reinforcing their understanding through practical application

6.4.4: Herbartian Lesson Plan Model

The Herbartian lesson plan typically follows these steps:

- **General Objectives**: Broad goals based on students' prior knowledge.
- **Specific Objectives:** Clearly defined goals outlining what students should achieve by the end of the lesson.
- **Introduction**: The teacher connects new content to students' existing knowledge through introductory questions.
- **Teaching Aids**: The appropriate materials, such as audiovisual tools, are selected to support the lesson.
- **Previous Knowledge:** The teacher evaluates students' existing understanding of the topic.
- **Statement of Aim**: The teacher clearly states the lesson's goal.
- **Presentation**: The teacher presents the material with guided questions and student interaction.
- **Explanation**: The teacher explains the answers to the questions, elaborating on the lesson’s concepts.
- **Blackboard Summary**: A summary of key points is written on the board for clarity.
- **Review Questions**: These help reinforce learning and evaluate student comprehension.
- **Home Assignments**: Tasks are assigned to help students practice and solidify their understanding.

6.4.5: Advantages of the Herbartian Approach

1. **Organized Teaching**: The logical sequence of steps ensures structured and effective teaching, helping new teachers avoid common mistakes.
2. **Apperception**: Herbart's theory of apperception helps students relate new information to their existing knowledge, making learning more accessible.
3. **Inductive and Deductive Methods**: This approach uses both methods, encouraging students to derive rules (inductive) and apply them to new situations (deductive).
4. **Recapitulation**: The application phase reinforces learning, allowing students to use what they've learned in new contexts.
5. **Correlation**: This approach promotes linking different subjects, enabling students to integrate knowledge across various domains.

6.4.6: Limitations of the Herbartian Approach

1. **Mechanical Teaching Method**: The rigid structure of the steps can limit the teacher's creativity and flexibility, making teaching feel mechanical and formulaic.
2. **No Consideration for Individual Differences**: The approach tends to treat all students the same, ignoring individual learning styles and needs.
3. **Limited to Knowledge-Based Lessons**: The Herbartian method is mainly suited for lessons focused on knowledge acquisition, not for skills or appreciation-based subjects.
4. **Teacher-Centered:** This approach prioritizes the teacher's role over student engagement, resulting in passive learning rather than active participation.
5. **Lack of Flexibility**: The approach doesn't allow for much variation in teaching methods, making it less suitable for creative or interactive subjects.
6. **Monotony**: The fixed sequence of steps can make lessons feel repetitive and uninspiring, leading to student disengagement.

Conclusion

In summary, while the Herbartian Five-Step Approach offers a structured and psychological method for teaching, it is not without its challenges. Its focus on knowledge acquisition and logical progression of content provides a solid foundation for learning but may not be as effective in fostering student engagement, creativity, or catering to individual differences. Teachers should adapt this method by leveraging its strengths and addressing its limitations to create a more dynamic and student-centered learning experience.

Self-Check Exercise-2

Q1. Name Herbart's educational ideology four elements for a successful teaching.

Q2. …….. considered entire knowledge as a single unit.

6.5 Bloom's Evaluation Approach to Lesson Planning:

Bloom's evaluation approach to lesson planning represents a significant innovation in education, transforming the processes of teaching, learning, and assessment. According to Bloom, education is a three-phase process that involves: (1) Formulating educational objectives, (2) Creating learning experiences, and (3) Evaluating behavioral changes or learning outcomes. These three main steps or phases guide this evaluation approach.

1. **Formulation of Educational Objectives:**
   Educational objectives are identified and defined based on students' entry behaviors, desired behavioral changes, and the learning experiences to be provided. These objectives are clearly articulated and written in behavioral terms, ensuring that they are specific and measurable.
2. **Creating Learning Experiences:**
   A suitable learning environment and engaging learning experiences are crafted to achieve the educational objectives. When planning for this step, the following factors must be considered:
   - Selection and organization of appropriate learning materials and experiences.
   - Choosing effective teaching strategies, tactics, or devices to foster the ideal learning environment.
   - Selecting necessary resources.
   - Planning teacher-student interactions and classroom activities.
3. **Evaluating Learning Outcomes:**
   The learning experiences are designed to foster positive behavioral changes in students. These changes are assessed to measure the effectiveness of the learning process. outcomes takes place, with different evaluation techniques (e.g., essay tests, objective and short-answer tests, practical exams) employed depending on the cognitive, affective, and psychomotor objectives. Different strategies are necessary to assess each type of objective effectively.

RCEM Approach to Lesson Planning:

The RCEM approach was developed by Indian educators at the Regional College of Education, Mysore (hence the name RCEM). This approach builds on earlier methods and incorporates Bloom's Taxonomy of Educational Objectives with modifications. The RCEM approach consists of three key components: **Input, Process, and Output**, which correspond to the introduction, presentation, and evaluation phases in traditional lesson planning.

1. **Input:**
   This phase involves identifying and specifying the objectives, also referred to as Expected Behavioral Outcomes (EBOs). These objectives are divided into four categories: (1) Knowledge, (2) Understanding, (3) Application, and (4) Creativity. The objectives are written in behavioral terms using seventeen

mental abilities. Additionally, the entering behavior of the learners is identified. The sequence of instructional procedures is determined based on these objectives.

2. **Process:**
   The process phase corresponds to the presentation stage in the Herbartian approach or the learning experience stage in Bloom's approach. The communication strategy used in this phase ensures effective content delivery and emphasizes interaction between the teacher and students. The teacher and students both actively participate, with the primary focus being to create learning situations that provide appropriate experiences to students.
3. **Output:**
   The output phase represents the actual learning outcomes (RLOs). During the process phase, learning experiences are provided to bring about the desired behavioral changes in students. These behavioral changes are considered genuine learning outcomes. Teachers typically assess the real learning outcomes through oral and written questions, marking this as the evaluation phase of the lesson.

Self-Check Exercise-3

Q1. RCEM stands for

Q2. The structure of the lesson plan is developed with the help of which aspects of teaching?

6.7-Summary:

A productive lesson isn't defined by flawlessly following a plan but by the shared learning experience between students and the instructor. An effective lesson plan doesn't need to be an exhaustive document predicting every classroom scenario or student response. Instead, it should serve as a flexible guide, outlining teaching goals, learning objectives, and strategies to achieve them. It acts as a reference to keep the lesson focused while allowing for adaptability. Ultimately, a successful lesson is one where both students and the teacher learn from each other, even when things don't go exactly as planned.

6.8 Glossary

Correlation: A mutual relationship or connection between two or more things.

Individual differences: It is defined as dissimilarity between persons that distinguish them from one another.

Experiences: the process of getting knowledge or skill from doing, seeing or feeling things.

6.9 Answers to the questions

Self-Check Exercise-1

Ans1. A lesson plan is a structured outline of general and specific objectives, along with the strategies used to help students achieve these goals under the teacher's guidance on a given day.

Ans2. Six

Self-Check Exercise-2

Ans1. 1. Interest

2. Apperception

3. General Method

4. Correlation

Ans2. Herbart

Self-Check Exercise-3

Ans1. Regional College of Education, Mysore

Ans2. Input, process and output

6.10-References and suggested readings:

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6.11-Terminal Questions:

1. What is lesson planning? What are the key characteristics of an effective lesson plan?
2. Explain the steps involved in lesson planning.
3. Provide a detailed discussion on the different approaches to lesson planning

UNIT-7

“Evaluation, Difference between assessment and evaluation, Functions, Importance or Uses of Evaluation, Construction of Norm-referenced and Criterion –referenced tests, Diagnostic testing and Remedial Teaching”

Structure:

7.1-Introduction:

Evaluation is the chief concern of the teacher, greatest premium of the parents and first anxiety of the students. Evaluation is relatively new term introduced in education vocabulary and in the educational measurement. It is supposed to judge the worth of all the educational outcomes brought about as a result of teaching-learning process. It is dynamic rather than static, with its methods and materials evolving to meet the changing needs of individuals and society. It represents a broader concept of assessment beyond traditional tests and exams.In evaluation, the focus is on broader personality changes and the major objectives of an educational program.

7.2 Learning Objectives: By the end of this chapter, students will be able to:
• Comprehend the meaning and concept of evaluation
• Recognize the significance of evaluation and differentiate it from assessment
• Identify various types of evaluation
• Develop norm-referenced and criterion-referenced tests

Prepare different types of test items, along with their advantages and disadvantages

- Understand diagnostic testing and remedial teaching

7.3 Meaning of Evaluation: Evaluation is a process of gathering data on behavioral changes to make decisions regarding the direction and extent of those changes. This is a relatively modern approach in education for assessing academic achievements, offering a broader scope than the traditional examination system. The starting point of the teaching process is the instructional or teaching objective. Without clear or specified teaching objectives, the direction of teaching remains unclear. To define teaching objectives, a teacher creates conditions that facilitate desirable behavioral changes in students, using specific teaching aids, methods, and resources. After these efforts, the teacher naturally aims to assess the success of achieving their objectives.Evaluation, in essence, provides the evidence that reveals the success or failure of the teaching process. It also serves as feedback, enabling teachers to improve their teaching methods, resources, and content delivery.

Definitions:

According to the Encyclopedia of Educational Research:

“Evaluation is a relatively new technical term, introduced to designate a more comprehensive concept of measurement then is implied in conventional test and examination.”

Rammer and Gage have defined the concept of evaluation in the following words: “Evaluation assumes a purpose or an idea of what is good or desirable from the stand point of the individual or society or both.”

In the words of Tollgerson and Adams: “To evaluate is to ascertain the value of some process or thing, thus educational evaluation is the passing of judgments on the degree of worthwhileness of some teaching process or learning experience.”

The NCERT has defined evaluation as follows: “Evaluation is the process of determining the extent to which an objective is being attained, the effectiveness of the learning experiences provided in the class-room and how well the goals of evaluation have been accomplished.”

7.3.1 Difference between Assessment and Evaluation:

Assessment refers to the process of objectively understanding the state or condition of something through observation and measurement. In the context of teaching, assessment measures its effectiveness. "Formative" assessment is conducted with

the aim of improving the teaching and learning process, while "summative" assessment is commonly referred to as "evaluation." Assessment focuses on learning, teaching, and outcomes, providing valuable information to enhance the learning experience. It is an interactive process between students and instructors that provides insight into students' understanding of the material. Instructors use this feedback to adjust the learning environment, while students use it to enhance their study habits and learning strategiesTypically, this information is learner-centered, course-based, anonymous, and ungraded.

Evaluation in contrast, it focuses on on grades and may include aspects beyond course content and mastery, such as participation, cooperation, attendance, and verbal ability. Evaluation involves the process of observing and measuring something to determine its value, either by comparing it to similar items or to a predefined standard. Evaluating teaching involves making a judgment as part of an administrative process.

Key Differences between Assessment and Evaluation:

Dimension of Difference	**Assessment**	**Evaluation**
Content: Timing, Primary Purpose	Formative: Ongoing, aimed at improving learning	Summative: Final, aimed at gauging quality
Orientation: Focus of Measurement	Process-oriented: Focuses on how learning is progressing	Product-oriented: Focuses on what has been learned
Findings: Uses Thereof	Diagnostic: Identifies areas for improvement	Judgmental: Determines an overall grade/score

Ideally, a fair and comprehensive plan to evaluate teaching would incorporate many data points drawn from a broad array of teaching dimensions. Such a plan would incorporate not only student surveys but also other key elements but also self-assessments, documentation of instructional planning and design, evidence of scholarly activity to improve teaching, and most importantly, evidence of student learning outcomes. But that is not all. A comprehensive evaluation of teaching would necessarily include various types of peer assessment, more commonly referred to as “peer observation.”

7.3.2-Functions, Importance or Uses of Evaluation:

The importance of evaluation are given as below:

1. To assess personality of the pupils:

The primary goal of evaluation is to assess students' overall personality, including their achievements, skills, interests, attitudes, aptitudes, intelligence, and physical,

emotional, social, and moral development. The insights gained from assessments can help refine educational programs to foster balanced and holistic personality growth.

2. To clarify objectives of education:

Another An important purpose of evaluation is to clarify the objectives of education. Evaluation is grounded in these objectives, helping Teachers develop a clearer understanding of the objectives for each subject. By assessing the objectives, teachers can determine the relevance and utility of various topics within the context of education.

3. To Assist in the Classification of Students:
Evaluation helps classify students into different groups according to their abilities.. Students may be classified into categories such as those with superior, average, or below-average intelligence. Grouping students with similar IQ levels and achievements together ensures uniform progress and minimizes educational wastage.

4. To Provide a Basis for Admission:
Another key purpose of evaluation is to assess students' capabilities, abilities, and suitability for admission to advanced courses. It sets the necessary educational benchmarks And the criteria students must fulfill to qualify for higher levels of study, setting a benchmark for competence.

5. To Award Scholarships:
Examinations and tests are frequently used to determine students' eligibility for scholarships. For example, the Indian government awards national scholarships based on achievement and intelligence test performance. Similarly, state governments grant scholarships to deserving students based on their academic achievements and intelligence test results.

6. To act as incentives:

Evaluation act as incentives for the students. Examinations set a clear cut goal before the students to achieve. Students make serious efforts to reach the highest level of achievement. Thus examination serves as incentive or stimulation for harder work.

7.3.3-Types of Evaluation:

Evaluation is of two types-

1. Formative Evaluation
2. Summative Evaluation

1. **Formative Evaluation**:- Under formative evaluation, a teacher estimates his educational program, method of teaching etc. with a view to their quality, effectiveness ad usefulness, so that educational program, method of teaching etc. can be made more effective and useful. It explains that formative evaluation

of the preliminary draft is done with a view to amend it in a desirable manner before giving it the final form. If some new methods of teaching are meaningful and useful for the students. Evaluation and interpretation of the obtained data gives Feedback to the teacher, which serves as a basis for necessary amendment and improvement is done to the method of teaching.

Often it is seen that a teacher keeps asking students different questions. These questions are helpful in learning the lesson and make teaching interesting and lively. These are called teaching questions. After a unit of a lesson has been finished, a teacher presents certain such questions before the students by which he can know how far the students have learnt about that unit or topic. It helps a teacher to know how effective his method of teaching is. After getting feedback from this, he makes suitable changes in the method of teaching. When a teacher evaluates the achievements of the students while teaching, it is called formative evaluation.

2. **Summative Evaluation:** By Summative Evaluation is meant to examine the suitability of certain previously developed educational program, curriculum, method of teaching, teaching aid etc. It helps to take a decision about the continuation of an educational program, method of teaching etc. For example, supposing a science text – book has to be selected for his class students, then all those science text-books will have been written on the science curriculum for high school students. Among these, the selected textbooks will be those that best align with educational objectives, curriculum standards, and other relevant criteria. Here summative evaluation will be carried out in respect of the previously written text-books. In this situation there is no possibility of effecting an amendment to the text-books written by different writers or published by different publishers. IN the same manner, if we want to estimate the desirability of any specified admission procedure, educational program, examination system etc. then it will be necessary to undertake summative evaluation so that it can be continued for the future years.

Summative evaluation is used to control the learning progress if the students during the course of teaching. By it both students and the teachers get feedback about the successes or failures of the teaching learning. Successes encourage students and their behavior is strengthened in the desirable direction, while failure tells him where he has committed an error and where he has to amend his behavior. A teacher comes to know feedback enables the teacher to recognize areas for improving their teaching methods and determine when remedial instruction is necessary for students. In this form of evaluation,teacher-made tests are commonly used. The teacher designs a mastery test to assess the proficiency of a specific topic, helping to determine whether students have effectively absorbed the material. Additionally, to identify the learning process and any learning errors, the teacher can also use observation techniques.

Self-Check Exercise-1
Q1. What do you understand by evaluation?

Q2. Name two main types of evaluation.

7.4- **Characteristics of Learning Among Pupils with Learning Difficulties**

Students enrolled in IRTP often experience one or more of the following learning challenges:

- Difficulty with memory retention
- Short attention span and susceptibility to distractions
- Limited comprehension skills
- Lack of motivation to learn
- Low self-confidence and expectations
- Weak problem-solving abilities
- Difficulty processing and organizing information
- Struggles with understanding new or abstract concepts
- Challenges in applying knowledge to related areas
- Need for additional time to complete tasks or assignments

Beyond these challenges, students may have diverse abilities and learning styles. Some may excel in visual learning, while others benefit more from auditory instruction. Certain students may require hands-on or tactile experiences to understand concepts effectively. Therefore, remedial teachers should implement a range of teaching strategies and activities to support students in overcoming learning barriers and reaching their full potential.

Self-Check Exercise-2

Q-1: Identify two characteristics of learning among pupils with learning difficulties.

Remedial Measures to Overcome Learning Difficulties:

Below are some strategies to address learning difficulties:

Effective Teaching Strategies for Remedial Instruction

- **Lesson Preparation:**
  Before starting lessons, remedial teachers should evaluate students' learning needs to develop well-structured teaching plans that enhance effective learning.
- **Designing Diverse Learning Activities:**
  Considering students' varying learning styles, teachers should incorporate a

range of activities that align with the same learning objectives. A sequence of simple, interconnected tasks is often more effective than a single, prolonged activity, as diverse approaches enhance comprehension.

- **Creating Engaging Learning Environments:**
  Teachers should design interactive and meaningful learning experiences, particularly in language subjects like English, by incorporating games and activities that foster student engagement and motivation.
- **Instructional Approaches:**
  Teachers should introduce concrete examples before presenting abstract concepts, breaking lessons into simple steps and adjusting the pace to match students' learning abilities.
- A variety of approaches should be used to help pupils understand new ideas through repeated and meaningful illustrations. Active participation should be encouraged using teaching aids, games, and technology.
- **Clear Instructions:**
  Due to difficulties with understanding written language, pupils with learning difficulties require short, clear instructions. Teachers should explain each activity thoroughly and, if needed, ask students to repeat the steps to ensure understanding.

Summarizing Key Points:

Reinforcing Key Concepts:

During lessons, teachers should regularly summarize important points and write them on the board to strengthen both auditory and visual memory. Connecting classroom learning to real-life experiences enhances comprehension and retention.

Boosting Motivation and Interest:

Students who frequently face learning challenges may become discouraged and disengaged. To maintain their interest, teachers can adapt the curriculum to better suit their needs, incorporating engaging activities and reward systems that build confidence and enthusiasm.

Promoting Active Participation:

Students with learning difficulties often struggle with confidence and may be more passive in class. Teachers should actively encourage their involvement, creating a supportive and engaging learning environment that fosters self-assurance and participation.

- **Focusing on the Learning Process:**
  Rather than only focusing on knowledge transmission, teaching should involve providing ample opportunities for practice, problem-solving, and critical thinking. Teachers should monitor pupils' progress and offer feedback, helping them to develop learning skills and boost self-confidence.
- **Individualized Attention:**
  Pupils may face different challenges in their learning journey. Teachers should observe each pupil's progress and, when necessary, provide one-on-one support before or after class to address learning gaps. Identifying common mistakes in assignments and offering prompt corrections can also help.

Self-Check Exercise-3:
Q-1 Name one remedial measure to overcome learning difficulty.

7.6-Construction of Norm-referenced and Criterion –referenced tests:

Norm -referenced and Criterion –referenced evaluations are basically two ways of interpreting results. In both these types, students are tested using achievement tests. The achievement tests used in case of norm-referenced evaluation are called norm-referenced tests, whereas those used in the case of criterion- referenced evaluation are known as criterion-referenced tests. With certain difference in their construction procedure, Both types of tests include a variety of question formats, such as multiple-choice, completion, true-false, and matching. Additionally, both are designed based on specific subject matter content. When administered to students, both tests yield scores indicating the number of items attempted correctly by them. Then, what is the difference two types of evaluation?

The difference lies in the way the test scores are interpreted. In other words, the difference lies in the purpose for which the evaluation is to be used.

When the purpose of evaluation is to differentiate the pupils in to pass and fail or successful and unsuccessful or more correctly speaking low achievers and high achievers, then the evaluation is termed as norm-referenced evaluation. For example, in our examination system at college level pass percent is 35. The process of the examination is to place or differentiate the students in to two groups i.e. those who pass the examination and those who fail the examination. The pass group may be called as high achievers group and the fail group may be termed as the low achiever group. Hence, this is norm- referenced evaluation.

Both types of tests include a variety of question formats, such as multiple-choice, completion, true-false, and matching. Additionally, both are designed based on specific subject matter content The evaluation is called as criterion-referenced evaluation. In this evaluation, the teacher before starting the actual teaching sets a criterion in terms of number of students achieving particular number of instructional objectives and strives to attain the same. For example, teacher may fix the criterion that “at least 80% of my students must attain at least 80% of the instructional objectives relating to the lesson.” This criterion is often expressed as the 80/80 criterion. The teacher delivers the lesson and then administers a test at the end to determine whether the set standard has been met. If students successfully achieve the criterion, the teacher proceeds to the next lesson. However, if some students do not reach the expected level of performance, they receive remedial instruction and are reassessed. This process goes on until the teacher finds out that the set criterion has been achieved. Then the teacher moves to the next unit or lesson.

7.6.1-Norm-Referenced Evaluation:

Norm-referenced tests are those that use the test performance of other persons on the same measuring instrument as a basis for interpreting a person’s relative test performance .A norm-reference measure allows us to compare one individual to another individual.

In this method a student gets his grade in relation to other students. Standardized tests such as scholastic aptitude test and I.Q. tests are the examples of norm-referenced tests. The teacher designs various test items, including objective-type questions, short-answer questions, and essay-type questions, while adhering to the principles of a well-constructed test. Additionally, norm-referenced tests can be used for screening purposes to place students into science classes based on their abilities, categorizing them as gifted, average, or slow learners.

7.6.2- Criterion-Referenced Evaluation:

Criterion- referenced tests measures an individual's ability or aptitude with reference to some criterion. A criterion-referenced measure is used when a teacher aims to assess what students can do rather than compare them to their peers. In this approach, performance levels are defined in advance before evaluating student achievement. Such tests are to be developed by teachers based on objectives of the lesson. The focus is on student's achievement of specific learning outcomes.

Both types of test items (Norm-referenced and Criterion –referenced) are constructed as given in the next step.

Self-Check Exercise-4

Q1.True or false:
Teaching should primarily emphasize the transfer of knowledge..
Q2.Define norm-referenced evaluation.

7.7-Summary:

Educational evaluation involves assessing and analyzing different aspects of the learning process. While it shares many methodologies with traditional social research, evaluation is distinct due to its context within political and organizational environments. This context requires skills such as group management, political awareness, and sensitivity to multiple stakeholders—skills not as heavily emphasized in typical social research. In this discussion, we introduce the concept of evaluation and explore key terms and issues in the field. Educational evaluation generally serves two main purposes, which can sometimes be at odds. Educational institutions often require evaluation data to prove effectiveness to funders and stakeholders, as well as to gauge performance for marketing purposes. At the same time, educational evaluation is a professional practice that educators must engage in to continuously assess and improve the learning experiences they provide.

7.8 –Glossary

Evaluation: Evaluation is a process of gathering behavioral changes by which a decision is taken about the directions and limitations of change.

Formative evaluation: Under formative evaluation, a teacher estimates his educational program, method of teaching etc. with a view to their quality, effectiveness ad usefulness, so that educational program, method of teaching etc. can be made more effective and useful.

Summative evaluation: By Summative Evaluation is meant to examine the suitability of certain previously developed educational program, curriculum, method of teaching, teaching aid etc. It helps to take a decision about the continuation of an educational program, method of teaching etc.

Norm-Referenced Evaluation: Norm-referenced tests are those that use the test performance of other persons on the same measuring instrument as a basis for interpreting a person's relative test performance.

Criterion-Referenced Evaluation: Criterion- referenced tests measures an individual's ability or aptitude with reference to some criterion.

7.9- Answer to Self-Check Exercise:

Self-Check Exercise-1

Ans1. Evaluation is a process of gathering behavioral changes by which a decision is taken about the directions and limitations of change.

Ans2. Two main types of evaluation are:

1. Formative evaluation
2. Summative evaluation

Self-Check Ecercise-2

1. Ans-Struggle to understand new or abstract concepts
   Have difficulty processing information effectively and often confuse details

Self-Check Exercise-3

Ans-1: Encourage students to actively participate in class activities

Self-Check Exercise-4

Ans1. False

Ans2. Norm-referenced tests are those that use the test performance of other persons on the same measuring instrument as a basis for interpreting a person's relative test performance.

7.10-References and Suggested Readings:

Das, R.C. (1989): Science Teaching in Schools, New Delhi: Sterling Publishers..

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7.11-Terminal Questions:

1 What does the term "evaluation" mean? How is it essential in the teaching-learning process?

2. Explain the characteristics and types of evaluation.
3. How does evaluation differ from assessment?

Unit-8

Preparing different types of items in accordance with the Bloom's taxonomy of instructional objectives

Structure:

8.1-Introduction:

Evaluation is a continuous process that assesses both educational goals and teaching-learning methods, ensuring ongoing improvement to make education dynamic and self-sustaining. Various test items are developed to measure learning outcomes.

8.2 Learning Objectives:

After completing this chapter, students will be able to:

- Understand how to prepare different types of test items, along with their advantages and disadvantages

Diagnostic testing and Remedial Teaching

8.3- Designing various test items based on Bloom's Taxonomy of Instructional Objectives, along with their advantages and limitations:

Test items are developed in alignment with Bloom's Taxonomy to achieve instructional objectives across three domains: Cognitive (Knowledge), Affective, and Psychomotor. Science teachers use two types of tests to evaluate students' learning across different subjects.

These are standardized and teacher made tests.

8.3.1-Standardized Tests:

Standardized tests are available in the market. A science teacher should be careful in selecting a standardized test from the market. The main considerations are as follows:

1. There should be definite possibility that the test will give them the information that they want.

2. Such a test should be reliable and valid.

3. A standardized test should consist of items suitable for students, ensuring that questions align with the level of difficulty addressed during instruction. Additionally, the items should be relevant and suitable for the students, and structured according to Bloom's Taxonomy of Educational Objectives..

8.3.2- **Developing Achievement Tests in Science:**

Science teachers typically design achievement tests to assess students' cognitive, affective, and psychomotor skills. However, in many cases, teacher-made tests tend to focus more on the knowledge aspect while overlooking other domains. The following are key steps in constructing an effective achievement test

1. Objectives of instruction should be defined and written in behavioral terms by following Bloom's Taxonomy of objectives, reflecting the terminal behavior of the learner.
2. The second consideration is the specification of the content.
3. The total number of test items should be determined based on the expected learning outcomes and content specifications, followed by the development of a blueprint.
4. Test items should be created in alignment with the blueprint, ensuring a balanced representation of different abilities and question categories.
5. It is crucial to review the test items to confirm their relevance and alignment with the expected learning outcomes

Self-Check Exercise-1

Q1. Standardized tests are available in the……..

Q2. True or false:

Teacher-made tests in science are primarily used to assess the cognitive and psychomotor domains.

8.4 Developing Various Types of Test Items:

1. Essay Type Questions:

Essay-type questions, such as short-answer or long-answer prompts, require the test taker to write a response that meets the item's criteria. From an administrative perspective, essay items are relatively quick to create. As an assessment tool, essay questions effectively evaluate complex learning objectives and the thought processes involved in answering them. They present a more realistic and applicable task, making it difficult for test-takers to guess the answers. Additionally, essay questions assess not only subject knowledge but also writing skills, including spelling and grammar. In India, they hold particular importance, as teachers often prefer designing them, and students tend to favor answering them.

Generally, essay tests involve students writing at length on a given topic, requiring them to discuss, enumerate, compare, state, evaluate, analyze, or summarize. This allows for a relatively free-form response, offering insights into how a student’s mind functions, their self-expression methods, their attitude, their ability to organize thoughts, and their originality. These responses often reflect the teacher's instructional approach.

Examples:

1. Describe the meaning and concept of educational technology.
2. How is sodium sulfate obtained from sodium carbonate?
3. Discuss the methods of teaching.
4. What is a lesson plan? Explain the essential steps involved in creating an effective lesson plan.
5. Identify the fundamental components of a cathode ray tube and describe the function of each.

Advantages:

The advantages of essay-type questions include:

1. They are relatively easy to prepare and administer.

2. They largly eliminate guessing.

3. They can assess higher mental processes. These processes are related to:

-the ability to summarize

-the ability to organize

-the ability to evaluate

-the ability to select important ideas and interrelate them.

-the ability to write well.

-the ability to be creative

4. Essay type questions can evaluate attitudes.

5. They promote effective study habits.

6. They encourage students to express in effective language.

7. They encourage creativity.

Limitations:

(1) The main drawback of essay-type questions is that they are challenging to assess and have low reliability

(2)There is subjectivity in grading**.**

(3)The scoring is time consuming.

(4)Some variables, like handwriting, neatness, language, etc. Reduce the validity of the scores.

2. Objective Type Tests:

Objective-type tests are written assessments in which students must choose the correct answer from a set of given options.

Advantages:

1. They can score objectively.

2. It is possible to cover entire content through objective type questions.

3. There is economy of time.

Limitations:

1. Guessing is possible.
2. Formulating questions is challenging.
3. Objective-type questions limit the development of effective writing skills..

Different Type of Objective Questions:

These are different type of objective questions such as:

- Very short answer type
- Completion type
- True false type

• Matching Type

• Multiple Choice Type

(1) Very Short Answer and Completion Type Items:
Very short answer items and completion items are both supply-type test items, requiring the test taker to provide a word, phrase, number, symbol, chemical formula, etc. They are similar, differing mainly in how the problem is presented. Very short answer items are presented as direct questions, while completion items involve incomplete statements that the test taker must complete. A fill-in-the-blank item requires the test-taker must determine the correct term based on the provided characteristics.

There are two types of fill-in-the-blank tests:

- **Easier version:** A word bank is provided, containing possible words to fill in the blanks, and each word is used once.
- **Medium Difficulty:** A word bank is provided, but some words may be used multiple times, while others may not be used at all.
- **Most Challenging Version:** No word bank is given, requiring test-takers to recall the correct term entirely from memory, demanding a deeper understanding and stronger recall than a multiple-choice test.As a result, fill-in-the-blank tests without a word bank are often more challenging and can be intimidating for students.

Examples:

1. What is the valency of the element with atomic number 15?
2. Name two salts that contribute to permanent hardness in water.
3. What is the chemical formula of Zinc Phosphate?
4. The chemical symbol for sodium is…….

(ii) True False Type Items:

True/false type items consist of a declarative statement, and the student is asked to indicate whether it is true or false, right or wrong, yes or no, correct or incorrect, etc. In each case, there are two options, and the student must determine which answer is correct and select it. Here are some examples

Directions:

Here are several statements listed below:

Read each one of them carefully. If the statement is true, encircle “T”. If the statement is false , encircle ‘F’.

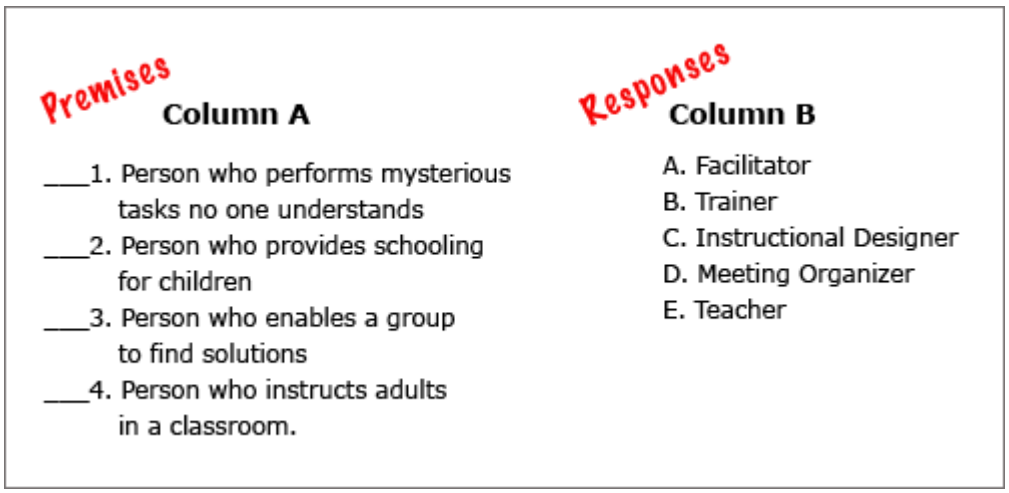
T.F. 1- If water at room temperature is warmed, it will increase in volume

T.F. 2- Acid should be poured in to water when being diluted.

3. Matching Type Items:
Matching type items consist of two columns, each containing terms or phrases. The student is tasked with matching each item in one column to the item In the other

column, the test taker must match the defined term with the characteristic that is most closely related. This type of item provides a specific term and asks the test taker to associate it with the correct identifying features. It is a test format that enables students to link terms, definitions, ideas, or images in one column to corresponding terms, definitions, ideas, or images in a second column.

Typically, the items in Column A, referred to as the 'premises,' are numbered, while the items in Column B, known as the 'responses,' are labeled with capital letters.



Multiple Choice Items:

Multiple-choice items include a question or an incomplete statement, followed by several possible answers. In this format, the test taker is presented with a list of potential answers for each question and must choose the correct one (or set of answers). There are two primary types of multiple-choice questions. The first type, called True/False questions, requires the test taker to choose all applicable answers. The second type, known as One-Best-Answer questions, asks the test taker to select just one correct answer from the options provided.

Example:

Which is most suitable for storing concentrated sulphuric acid?

(a) Copper vessel
(b) Aluminium vessel
(c) Glass vessel
(d) Earthen vessel

Short Answer Questions:

Short answer questions are those that can be answered in just a few wordsThe examiner gives a definite direction about the approximate number of words to be used

in answering the questions.

Examples:

1. Write a note on energy in 40 words.

2. Write a short note on sound pollution in 30 words.

Advantages:

- They are specific
- They are easy to evaluate
- They cover a broad range of the course material.

8.4.1-Diagnostic testing and Remedial Teaching:

Diagnostic testing focuses on addressing persistent or recurring difficulties that remain unresolved by the standard corrective methods of formative evaluation. It aims to identify the underlying causes of these issues that formative evaluation cannot address. This process involves the use of specially designed diagnostic tests and various observational techniques. Once the root cause of the learning problems is identified, it helps in creating a plan for remedial action.

Formative evaluation, on the other hand, aims to assess how well students have met the instructional objectives for a specific unit. If students do not achieve certain objectives, it provides the teacher with an overall understanding of the areas where students are struggling.

In contrast, diagnostic evaluation targets very specific weaknesses within a subject. For example, most fifth-grade students may perform well with division of whole numbers, but struggle when one of the numbers is a decimal. In such cases, the teacher can diagnose this specific issue through observation, identifying the problem of dividing numbers involving decimals. Based on this diagnosis, the teacher can plan remedial instruction for students who need additional support.

The main functions of Diagnostic evaluation are:

1. Placement
2. Diagnosis of pre-requisite entry behaviours and skills
3. Diagnosis to determine the extent of prior mastery of course objectives
4. Placement diagnosis for alternate teaching strategies
5. Placement diagnosis for alternate curricula

As a teacher, your primary role is to foster quality learning among students. This can only be achieved when you act as a guide and encourage active student participation in the learning process. Throughout the teaching-learning journey, it is essential to identify areas where students make mistakes. This is a critical stage where you must DIAGNOSE and create instructional material for REMEDIAL TEACHING to ensure the

desired learning outcomes.

At this stage, your role is similar to that of a doctor. Just as a doctor diagnoses a disease through tests and prescribes medication accordingly, in education, diagnostic testing serves as the STEP, and remedial teaching acts as the PRESCRIPTION. Both diagnostic testing and remedial teaching are crucial for ensuring effective learning and improving the quality of education. This article aims to discuss how to organize diagnostic tests in the teaching-learning process and implement appropriate remedial actions.

Typically, after completing a unit or topic, you administer a test to assess student achievements. After evaluating the results, you may find that some students performed well, while others did not meet expectations. In these instances, it is crucial to explore the underlying reasons for the low achievement or slow learning. Identifying the specific areas where difficulties arise or the concepts where errors occur leads to diagnostic testing.

Diagnostic testing involves investigating students' difficulties and identifying the underlying reasons. The follow-up process, known as remedial teaching, helps students address these deficiencies. As a teacher, you must be skilled in preparing or arranging corrective instructional materials to enhance the quality of learning.

8.4.2 Remedial Teaching emphasizes the following key points:

Corrective materials should be tailored to address the specific challenges faced by individual students.It is important to analyze the work of slow learners through careful observation., interviews, and diagnostic testing.A careful evaluation of these methods helps determine the kind of corrective materials needed and whether they will adequately address the specific difficulties.

1. **Corrective materials** should be graded, self-directed, and allow students to work independently. The written instructions accompanying the materials should be easily readable and understandable by the students.
2. **The corrective material** must allow students to progress at their own pace.
3. The material should encourage **systematic tracking of student progress**.

The diagnosis derived from a graded test provides a clear direction for remedial teaching. The teaching strategy should focus on exercises in the areas of difficulty until mastery is achieved. Additional testing is recommended to evaluate the effectiveness of remedial teaching.

Self-Check Exercise-2:

Q1: What are essay-type questions?
Q2: Define objective-type tests.

8.5 Summary:

In this chapter, we have discussed **Diagnostic Testing**, an essential part of the teaching-learning process. It involves a detailed examination of learning difficulties

and aims to analyze, not just assess. The strategy you use to address the weaknesses of learners is known as **remedial teaching**. Diagnostic testing leads to remedial teaching, where you prepare instructional materials that foster quality learning by adopting various methodologies to meet individual or group needs.

8.6 Glossary:

- **Achievement tests:** Assessments that evaluate the knowledge, skills, and abilities students have acquired.
- **Diagnostic testing:** Tests designed to identify specific learning deficiencies in individual students at particular stages.

Remedial Teaching: the concept of re-teaching and reinforcing previously taught basic skills to improve student's outcomes.

8.7 Answers to the questions

Self-Check Exercise-1

Ans1. market

Ans2.false

Self-Check Exercise-2

Ans1. The essay test is a form of assessment where students are asked to discuss, enumerate, compare, state, evaluate, analyze, summarize, or criticize a given topic, requiring them to write a specified length based on the processes mentioned above.

Ans 2: Objective-type tests refer to written assessments in which students must choose the correct answer from a set of available alternatives

8.8-References and Suggested Readings:

Das, R.C. (1989): Science Teaching in Schools, New Delhi: Sterling Publishers.

Kohli, V.K. (1998): How to Teach Science, Ambala: Vivek Publishers,.

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Mohan, Radha (2002): Innovative Physical Science Teaching Methods. New Delhi:

Sharma, R.C. (1998): Modern Science of Teaching, New Delhi: Dhanpat Rai and Sons,.

8.9-Terminal Questions:

1 . **Write a brief note on diagnostic testing.**
2 . **What is remedial teaching? Explain it in detail.**
3. **Write a brief note on essay-type questions. What are the benefits of essay-type questions?**